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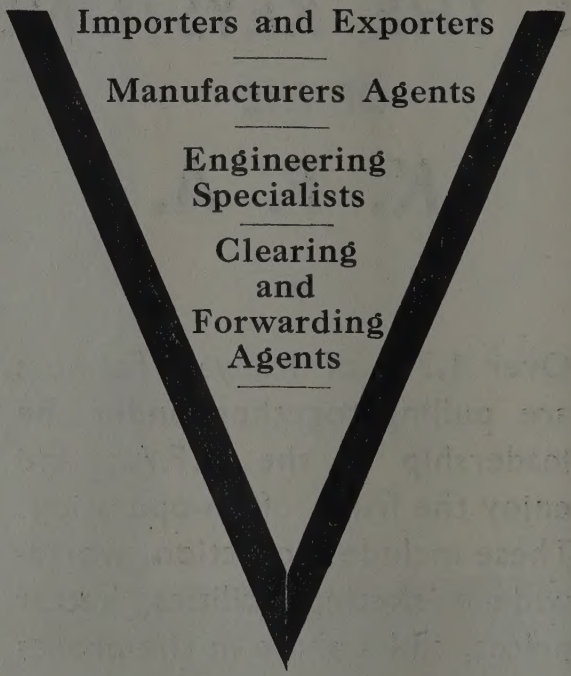

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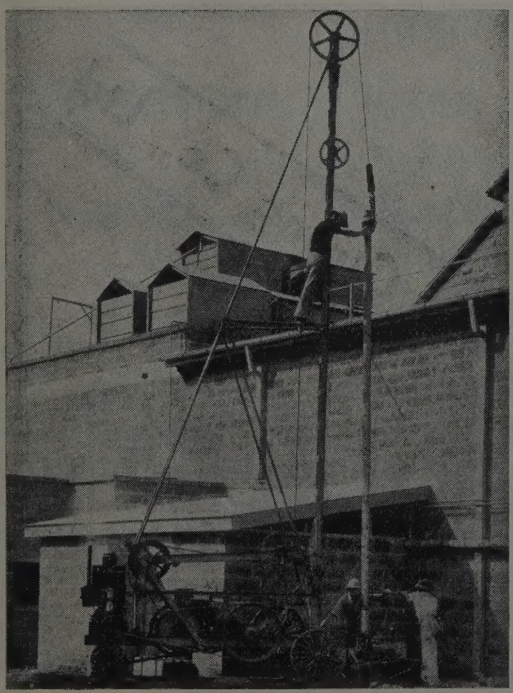

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to Amani.

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THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

PLOUGHMAN'S QUERY

Final Ruin fiercely drives
Her ploughshare o'er creation.

Thus wrote Edward Young, and in this issue (p. 130) we print extracts from a recent editorial in "Tropical Agriculture" on the folly of deep ploughing. It contains the views of an American farmer, Mr. E. H. Faulkner, whose criticism of the mouldboard plough will interest all and surprise many. For generations the British farmer has been a firm believer in the mouldboard plough, and Benjamin Franklin's words "Plough deep while sluggards sleep" must have echoed in the minds of many whose pride it was to keep the land in good heart. Yet a note of warning is struck by Mr. F. B. Hewson of Rongai, Kenya, a letter from whom also appears in this number (p. 131), in which he suggests that, for wheat growing in Kenya, one deep ploughing is better than two. He wishes to avoid disturbing the plant residues which are turned in by a deep ploughing, and he maintains that any subsequent cultivation should not go deeper than half the depth of the original ploughing.

These two views are opposite, in that Hewson believes in turning-in the grass or stubble, while Faulkner roundly condemns the mouldboard plough as an agricultural implement and he prefers to use the heavy disc harrow, which loosens the surface but does not turn under the grass sod or cover crop. Hewson expounds a policy of deep ploughing, but he limits it to one ploughing and stipulates that there should be a good growth to be turned in. Several people are of the opinion that the introduction of the modern plough into native agriculture in East Africa would spell disaster, and thus we must note that Hewson is thinking only of European farming in the Kenya highlands.

A paper by Dr. B. A. Keen which was reprinted in the October, 1943, number of this Journal contains observations of interest in this discussion. In field experiments with potatoes and sugar-beet at Rothamsted it was found that double ploughing gave only an insignificant increase in yield over a single ploughing, not nearly enough to pay for the extra work. Deep ploughing every year was no more effective than shallow ploughing, but there was slight evidence that an occasional deep ploughing gave a small increase in the yield of root crops. This was the experience in England, and it does not necessarily hold in East Africa, yet it must be remembered that the results of these field experiments came as a surprise to most English farmers.

Dr. W. S. Martin's research work in Uganda on soil structure may explain some of the points at issue. His paper which appeared in the April, 1944, number of this Journal has been summarized in No. 8 of "Farming in the Highlands", which is published as a supplement to the Kenya Information Office Fortnightly (No. 44). According to him, the mere presence of a grass cover may not be sufficient to improve soil structure: the grass must be of a deep-rooted type which promotes the binding of soil particles into crumbs or minute clods. Rain can then penetrate rapidly to the subsoil, run-off and erosion are thereby diminished, and thus full use is made of a limited rainfall. Hewson's one deep ploughing instead of two or more will conserve the crumb structure, and in East Africa there must be numerous tragic demonstrations of the folly of *frequent* ploughing. Faulkner may be right, too, in that the use of the mouldboard plough in a soil of powdery tilth would allow the rain to seal the pores of the surface soil with consequent lack of penetration, and might cause anaerobic decomposition of the buried organic layer, with toxic effects on the crop. The use of mulch on his "house builders' dump" may have caused water containing carbonic acid gas to dissolve the lime of the waste cement which all builders delight in scattering round a new house, and the resulting granular structure may have been due to flocculation of the clay colloids, a chemically-induced crumb structure.

Thus Faulkner may be right in condemning the use of the mouldboard plough under the particular soil-structure conditions of his experiment, but his generalizations may have been

pushed too far. We find it difficult to believe that any harmful effects of buried organic manures would not have been noticed in England long ago, since agricultural practice there has developed through trial and observation over many generations. But the disc harrow instead of the mouldboard plough may be necessary where the structure of the soil is poor, and, even where the structure is good, it may possibly be advisable as a means of preserving the crumbs which have been formed under a suitable grass cover. The issue must be greatly affected by conditions of soil and climate, and these vary so much in East Africa, even taking the Kenya highlands alone, that many points for and against will be found under each set of circumstances. Nevertheless we appear to be given a choice between deep ploughing and disc harrowing, between turning-in the grass or stubble and leaving it as a mulch in order to improve the soil from the surface downwards. Extensive field experiments might settle the question; tedious argument may only confuse the issue; and to proceed further with this discussion would only encourage the Shakespearean criticism that "he draweth out the thread of his verbosity finer than the staple of his argument".

D.W.D.

AN AMERICAN'S VIEWS ON DEEP PLOUGHING

The following is an extract from the editorial in "Tropical Agriculture", August, 1944, which deals with the views expressed in a book entitled "Plowman's Folly" written by Edward H. Faulkner, an American farmer who had considerable experience in experimental work and as a county agent in Kentucky.

The main charge which the author of "Plowman's Folly" lays against the mouldboard plough is that the act of soil inversion places crop residues and green manures, and all else added as amendments to the soil surface, below the reach of the roots of the crop that is being grown. It creates a highly absorbent layer below the surface which, through its large water-retaining capacity, interferes with upward capillary movement of soil moisture, in that it literally produces a "sandwich" layer between soil that is rapidly drying out above and moist soil below. Furthermore, under these conditions, the organic matter does not decompose properly. The carbon-dioxide it generates by oxidation sets up a toxic subsoil concentration which adversely affects the micro-organisms controlling decay, and may even penetrate into the rooting zone above. The mass of sour buried vegetable matter takes an inordinately long time to liberate its store of nutrients, and the growing crop may absorp very little of these valuable by-products. The bare exposed soil material above the sandwich organic layer is easily eroded by water and wind, and constantly exposed to excessive evaporation from wind and sun. An artificial condition of drought exists between the buried organic layer and the sun-baked surface. In the long run the topsoil is entirely destroyed and lost. Out of these mishaps have emerged such catastrophes as the great Dust Bowl disaster of the 1930's when millions of acres of agricultural land had to be abandoned in the south-central States of North America.

The correct procedure to follow in cultivation, according to Edward Faulkner lies in *the use of the heavy disc harrow which rips up and loosens the surface but does not turn under the grass-sod, stubble or cover-crop.* Capillary uplift of water is thus not arrested, and evaporation from the surface is greatly reduced by the blanket of mulch that covers it. Furthermore, the organic mulch prevents run-off during rains and hence loss of soil through erosion is lessened. His contention therefore is that we should increase the depth of our soil from the top downwards rather than from the bottom upwards which is the method attempted when trash, litter and manure are buried deep. He advocates working from the top by piling up an accumulation of decaying organic matter which is Nature's way as seen in forest and meadow. Indeed the first cause of Faulkner's realization of the evil done by the mouldboard plough was his observation that crop-plants growing in the hedgerows resist drought markedly while the plants out in the bare baked fields wither and die. In the hedgerows the ground has not been ploughed and the surface is covered by a mulch of decaying vegetation and loose soil, circumstances which help to conserve soil moisture.

The ideas engendered in Faulkner's mind were put to exhaustive test by him, first during the years 1930 to 1938 in his back garden where, to quote his own words, the soil was "better suited to brickmaking" than to the growing of vegetables, being just harsh "cellar dirt"—a house builder's dump—devoid of all organic matter. It was so hard when dry that a sharp spade made no perceptible impression on it, and the clods were as "sharp as broken stone", and so sticky when wet that it clung to his boots in lumps "as big as he could

carry". By a system of surface mulching with dead leaves, coupled with a process of working decayed weeds and vegetable residues into the upper layer and not burying them, the soil had become so much improved in seven years that the surface was "as granular as sugar", and every crop planted thrived and produced as well or better than crops grown by neighbours on inherently much superior soil.

The success of the garden experiment inspired a much larger test on a field scale on derelict farmland in Ohio. Here again the method practised was to incorporate green manures into the soil surface with a disc harrow, and to plant or sow direct on to the trashy land, usually, however, at spots compacted by a crude implement specially designed for the purpose of marking out the planting sites in rows. The green manure mainly used was rye, which gives two crops a year. Alternatively weed growths were used as mulch.

A careful study of ploughing versus new methods of soil cultivation has been undertaken on experimental farms in Iowa by officers of the State and of the United States Departments of Agriculture. The new methods were disc-harrowing, as advocated by Faulkner, listing and subsoiling, all of which loosen the soil without turning it over. One object was to leave the stubble on the surface so as to afford a check to erosion; another was to provide decaying organic matter to act as manure. In the Iowa tests so far the new methods are stated to have produced bigger soya bean crops, to have saved one-third to one-half the man and machine power needed for ploughing, to have reduced erosion from 34 to 10 tons of soil lost per acre, and to have kept down weeds better than customary ploughing methods.

A KENYA FARMER'S VIEWS ON PLOUGHING

The Editor, East African Agricultural Journal.

Sir,

With reference to this knotty problem of wheat growing again.

I am convinced that one deep ploughing is better than two; I know that they say in England, and rightly so, that "another ploughing is another bag". But other climates, other conditions.

I maintain this idea only on condition that there is a good growth to plough under and that the one and only ploughing is done at least twelve weeks before planting, and that whatever cultivation is done afterwards never under any circumstances goes deeper than half the depth of the original ploughing.

In working the land in this way you do not disturb the growth you have ploughed under, which is, I think, all important in Kenya.

I know there will be a shoal of arguments against this, and it would be interesting to see them in the *Agricultural Journal.*

F. B. HEWSON.

WRITE SIMPLY

They said.—The optimum conditions for the storage of seed are obtained when both temperature and humidity are maintained at a low and constant level.

Try.—Constant cool and dry conditions are the best for storing seed.

They said.—The successful storage of seed is dependent on the moisture content before storage being reduced to a sufficiently low value.

Try.—Seed must be well dried before it can be successfully stored.

They said.—Their increased height adds to their conspicuousness, both auditory and visual.

Try.—Their increased height makes them easier to hear and to see.

They said.—The arrangement functioned well.

Try.—The arrangement worked well.

They said.—A prolonged spell of drought conditions.

Try.—A long dry spell.

They said.—So that access may be effected to the building with the minimum of delay.

Try.—So that the building may be entered with the least delay.

They said.—It seems not unlikely that the immediate difficulties may become so great that it will be impossible to continue to place reliance on supplies from overseas.

Try.—Difficulties may become so great that supplies from overseas can no longer be relied upon.

NOTES ON THE GROWING OF CYPRESS TIMBER ON FARMS

By R. M. Graham, Assistant Conservator of Forests, Kenya Colony

(*Received for publication on* 19*th July,* 1944)

In districts where they thrive, certain species of Cypress (*Cupressus*) are probably about the most useful general-purpose trees which can be grown for poles and timber on East African farms, for estate use, or even for sale to local saw-millers.

Among the exotics Eucalypts or Wattle are usually and rightly chosen for fuel crops, and they provide poles as well. They are very fast indeed to begin with, but this rate of growth falls off rapidly under plantation conditions and they mature comparatively slowly.

The commonly planted species of gums produce hard and heavy timbers for which there is not much demand.

Pinus radiata (*insignis*) is fast growing and the timber makes excellent crates and cases. It is used extensively in Australasia and in South Africa for building and other purposes and is lighter in weight than most Cypresses. The tree, however, is somewhat exacting in its soil requirements and the timber, unless impregnated with a preservative, is unsatisfactory when exposed to the weather. There are, of course, other species which may be worth growing, but information about most of them is lacking.

In the meantime, Cypresses are easy to raise in nurseries and in plantations. They appear to thrive over a fairly wide range of conditions. Their timbers are reasonably light in weight, take nails readily without splitting and are much more durable and less liable to warp, when exposed to the weather, than are those of *Pinus radiata* or the *Podocarpus* spp. of East Africa. They have been grown fairly extensively in Kenya for more than twenty years and a certain amount of technical information is now available about them. Yields per acre will probably be high, and although final figures are not yet available it is known that thinnings 6 in. to 8 in. in diameter at breast height, capable of being converted into sawn timber of value, are obtainable from average plantations thirteen to fifteen years of age. It will probably take about forty years to grow a well-tended final crop in good forest land to an average diameter of eighteen inches at breast height.

Cypress timbers do not absorb preservatives as readily as do those of the softer pines but they have a fair measure of natural resistance to ordinary rots. They are not termite-proof, but then nor are any other fast-growing species at the higher altitudes.

This article touches on problems connected with the establishment and maintenance of Cypress plantations. It is based on experience with the silviculture of some thousands of acres of crops up to the age of eighteen years in Kenya, approximately on the equator. I understand that in Tanganyika the various species mentioned will thrive at altitudes of from 1,000 to 2,000 feet lower than those suggested for Kenya. I have had no direct experience of this but I imagine that a heavier rainfall in the highlands of Tanganyika might have a good deal to do with the problem.

General Principles

For farm plantations, we may assume that even-aged woods will be made, either on ploughed grasslands, or else on land which has been, or is being, cultivated by squatters. In either case good results can be obtained only if couch grasses are kept out of the area. For various reasons it is generally thought to be very desirable to grow broad-leaved species in mixture with conifers, and this point will be mentioned again in due course.

We do not necessarily want to grow timber at the fastest possible rate. Although there is little evidence to show that very fast-grown Cypress will produce markedly inferior timber, this possibility cannot be ignored. On the other hand, there is no evidence at all to show that the highest quality of timber would be produced by growing the trees very slowly; nor is there any strong demand for such special material at present.

Cypresses of the species commonly grown in Kenya are by nature fast-growing in favourable circumstances, and provided the timber produced is suitable for ordinary purposes, there is no reason why we should not take advantage of this fact. Our aim is to find out the cheapest, easiest and quickest way of growing the maximum quantity of a fair-quality timber. Naturally, we do not want to grow an unsatisfactory timber, however cheaply.

An even rate of growth is one of the most important factors in determining the quality of timber produced. A tree grown for a number of years under conditions of semi-suppression,

and then suddenly freed from competition by means of a drastic thinning operation will consist of a layer or core of relatively dense, slow-grown wood, surrounded by a layer of much lighter wood. Further periods of suppression and freedom will be reflected in the log by alternate bands of heavy and of light wood. Planks cut from such a log tend to warp and split in seasoning to an abnormal extent.

It is not practicable to attempt to get growth rings of equal width throughout a log, but by timely thinnings and prunings we can try to avoid any violent changes in the rate of growth, at the same time giving the tree every chance of forming even-grained timber without unnecessary loss of time.

Other things being equal, we can take it that over-shadowing or over-crowding will reduce the rate of growth. So, for a season or two, will a very severe green pruning. Kikuyu grass in a newly planted area will kill or stunt most species, but it should not be allowed to establish itself. On the other hand, a thinning among healthy, growing trees which are competing for light and soil moisture will allow the surviving stems to grow more rapidly. The forester, therefore, can control the rate of growth to a limited extent, although control is confined almost entirely to the rate of diameter increment and not to that of height increment.

The age, or height, at which trees first become over-crowded and ready for a thinning depends largely on the initial planting espacement. In mixed plantations the choice of secondary species and the type of mixtures made are other factors which will affect this. These points will be dealt with in their turn.

Choice of Species

As with other crops, the best results may normally be expected on land best suited to the crop in question. I do not suggest that the most valuable farm land should be put under timber, but it is as well to remember that timber is a crop, no less than wheat or coffee. On most farms there are areas of fair land on slopes too steep to be cultivated annually. These, if not wanted for pasture, may be made to yield a return in timber. Under proper management broad windbreaks, an asset to any farm, may also be classed as production areas.

In Kenya, *Cupressus macrocarpa* normally thrives in deep soil at altitudes above the 8,000 feet contour. *Cupressus lusitanica* does better at between 7,000 feet and 8,000 feet in good soil. For both these species the rainfall should be forty inches per annum or more, and fairly well distributed. It is known that *Cupressus lusitanica* will do well at considerably lower altitudes, where there is a corresponding increase in the rainfall, but at present we have little data on this subject.

Cupressus torulosa the Himalayan Cypress, appears to be able to stand drier conditions as it has done fairly well in Nairobi at 6,000 feet on rather poor soil. It is slower growing than the two species previously mentioned and the timber may be somewhat harder and heavier. In India it is stated that the timber is about as durable and as good as that of *Cedrus deodara*, which is high praise. The only authentic *Cupressus torulosa* plantations that I have seen in Kenya are very young. The indications are that this species will do well enough at higher altitudes; but on the other hand, if it is very much slower growing, it might not be worth considering it excepting in localities definitely unsuited to *Cupressus lusitanica* or *Cupressus macrocarpa*.

Cupressus arizonica grows even more slowly than *Cupressus torulosa* and is even more drought-resistant. It is very doubtful if it would be worth growing this species for timber, but it makes good windbreaks and poles.

Cupressus sempervirens, the European Cypress, is slow and hardy and might be worth a more extended trial than it has had so far in the 30 in. to 40 in. rainfall belt.

One of the early introductions of exotics into Kenya was, apparently, a very bad strain of *Cupressus benthami*. This type was rather extensively planted in small plots twenty or thirty years ago. It grows strongly even on shallow soil and regenerates itself naturally and freely by seed. Nevertheless, it should be avoided, as the main stem is apt to be crooked and the branches very large and coarse. Reliable Cypress seed, taken from selected plantations of good form, is always obtainable from the Kenya Forest Department.

There are many other species of *Cupressus*, some of which will no doubt turn out to be very well worth growing, but for the present, at any rate, information about them is lacking here.

Various broad-leaved species have been grown in mixture with cypress and the following are worth considering:—

Grevillea robusta.—Probably about the most satisfactory, on present indication, below 8,500 feet. At higher altitudes it grows more slowly than *Cupressus macrocarpa* and it is apt to be

suppressed. Mature trees are said to have rather large, spreading crowns, so that it will be necessary to give them plenty of room in which to develop. It is also necessary to protect young plants from bushbuck and duiker. The timber of Grevillea is excellent, being light and soft and highly figured. At Amani the tree is said to be short-lived.

Acacia melanoxylon is also a favourite food of buck. At first it grows faster than Cypress but at altitudes of less than 8,000 feet it tends to grow very slowly after it has reached the age of about twelve years. Below the 8,000 feet contour it would probably do better with a rainfall of 60 inches. The timber is said to be a fairly good cabinet wood. Trees are often attacked and even killed by *Loranthus* spp.

Polyscias kikuyensis.—This indigenous tree is too slow-growing at first, but by judicious management it ought to be possible to grow it in mixture with Cypress in areas with a rainfall of 50 inches per annum or more. The light, soft, white timber is always saleable. It is not easy to collect enough seed to raise it in quantity. It has a large spreading crown.

Hagenia abyssinica.—Another indigenous tree, which does best at altitudes of 9,000 feet and over. At first it is too fast and later too slow; but with care it should be possible to grow it in mixture with Cypress, provided the crown is given plenty of room.

Dombeya goetzenii.—Indigenous. Too fast at first, but reasonable later on. Another tree which probably wants plenty of crown space, in order to develop satisfactorily. The hard, white timber is in fair demand. Not recommended excepting if planted in scattered groups in Cypress. In line-by-line mixtures it is apt to kill out Cypress, or suppress it very severely.

These are all the secondary species of which I have had experience, though it would be very desirable to find others.

Initial Espacement

Following classical European forestry practice, some of the earliest Cypress plantations in Kenya were made at four feet by four feet. Tree leaves without access to a reasonable amount of sunlight are of no value to the tree. In a close stand, lower branches are soon over-shadowed. The leaves fall off and the branches die. In many species these dead branches soon become brittle and fall off, i.e. nature prunes the bole. In the case of the Cypresses, the dead branches are unusually persistent, and although the average diameter of branches in a crowded plantation is kept very small, self-pruning is extremely slow. Several other important factors have to be considered before deciding upon the initial planting espacement:—

(i) There is severe competition in a crowded stand for crown space. The rate of growth depends largely on the area of leaf-surface which each tree can provide for itself; but the leaves must be exposed to sufficient light to enable them to function.

(ii) Root competition for soil-moisture is severe in a crowded stand. This is particularly marked in a country like Kenya, where rainy seasons may be followed by almost completely dry spells lasting for months.

(iii) The natural rate of growth of the Cypresses we use in Kenya is far greater than the natural rate of growth of, say, larch, spruce or firs in Europe. Overcrowding of an even-aged stand may result in permanent injury to every tree. In nature, growing conditions vary, and certain seedlings soon outstrip their fellows and become dominant. They provide themselves with growing space by suppressing weaker trees. In an artificial plantation conditions are approximately equal for all and growing space for selected trees must be provided by cutting out others. In many cases the trees removed may be as good in every way as those which are left. A thinning does give one the opportunity of getting rid of inferior stems but the primary object is to provide more growing space for the crowns and roots of those which are to remain.

(iv) The cost of high pruning in Europe is often prohibitive. It is, however, financially possible in Kenya to grow trees at a relatively wide espacement to allow them to develop more freely, and at the same time to prune them artificially in order to get clean, knot-free timber.

(v) The cost of close-planting is higher than that of planting at wider espacements, and in the short planting season usual in East Africa the time taken in transporting trees to the planting area may also be important.

We know now that four feet by four feet is unnecessarily close. For some years the Kenya Forest Department planted Cypress at six feet by six feet and later they adopted eight feet by eight feet as the standard. Personally I believe that nine feet by nine feet is perfectly satisfactory, providing that the stand is fairly complete by the end of the second season, and providing that the area is as free from couch grasses as it ought to be.

System of Planting Mixtures

It is believed that a pure crop of conifers is liable to affect soil-conditions adversely, and that pure crops are more liable to suffer from fungal and insect attacks than are mixtures. It is always difficult to find two or more useful species which, throughout the period when they are putting on their main height increment, will grow at approximately the same rate. I have touched on the question of the choice of species already. Here we need only consider three main systems of making mixed plantations:—

(i) Alternate lines of Cypress and secondary species.

(ii) Alternate strips, each strip consisting of several lines of Cypress, followed by several lines of the secondary species.

(iii) Plantations of Cypress, containing groups of the secondary species scattered throughout the area at more or less regular intervals.

For years, the first system, line-by-line planting of Cypress and another species, has been the standard Forest Department practice. It is not a bad method, but it has one serious disadvantage. It is almost impossible to find a secondary species which, while producing a reasonably useful timber, will grow at approximately the same rate as the Cypress. The result of this is that at certain times each line of the slower-growing species is apt to be overshadowed by two lines of the faster-growing. It is, of course, easy enough to adjust matters by selective thinnings; but in practice such thinnings must often result in the cutting out of large numbers of the best developed trees of the faster-growing species. If this is not done, it is not possible to retain a fair proportion of the slower-growing species for the final crop. A further disadvantage is the fact that, whereas it is easy to raise large numbers of Cypresses, seed of some of the more desirable of the secondary species is scarce at times. It is true that in favourable conditions, at certain altitudes, *Grevillea* will grow at the same rate as Cypress, but this is by no means always so.

The advantages of the system are that it is easy for labour to plant the trees in alternate lines without much supervision, and that trees of the secondary species can be evenly scattered throughout the plantation in the desired proportion, by judicious thinnings in later years.

In order to overcome the main disadvantages mentioned above, the strip method was devised. The advantages here are that if three or more lines of the same species adjoin, differences in the rate of growth become of less importance, since only the outer rows of each strip will be affected by trees of the other species. It is unnecessary for the strips to be of equal width and one can therefore economize, to a certain extent, in plants of the secondary species if this is desired.

Disadvantages are:—

(i) The mixture is not so complete, particularly if the strips consist of five or more lines together of one species.

(ii) Rather more supervision is required when planting.

(iii) If one species is much slower than the other at any stage of growth, and if strips are narrow, an undue proportion of the faster species will consist of rather free-growing marginal trees, liable to have undesirably large branches on the open side.

(iv) If the strips of both species are wide—say five lines or more—it will not be possible to keep the proportion of the secondary species down to anything much below 50 per cent in the final crop. This, of course, will not apply if the strips of the secondary species are originally narrower than those of the main crop. Nor would the fault be a serious one if the two species were of approximately equal value.

(v) It sometimes happens that a large proportion of the trees of one species are killed by buck, frost or other causes. A strip plantation then becomes, to all intents and purposes, a series of narrow belts of one species. Under other systems there is at least a crop fairly well spread over the whole area.

The third method, group-planting, seems to me to be better than the other two, and it is therefore discussed in more detail later in the article. The main disadvantage to it is that considerably more supervision is required during actual planting operations. Normally, in the final crop after all thinnings have been completed we want to retain about fifteen per cent of the secondary species and eighty-five per cent of the main crop, Cypress. It is, I consider, extremely important to keep all trees in a vigorous, healthy, growing condition throughout their existence. Severe checks, due to overcrowding, not only affect the quality of the timber, but they may also make weakened trees much more liable to succumb to fungal or insect attacks. If the two species are growing at different rates it is not going to affect the result much if the groups are faster or slower

growing than the main crop—within reason. Thinnings can be carried out without the necessity of having to sacrifice numbers of the best-grown trees of the faster species in order to allow a fair proportion of the slower to develop satisfactorily.

Group Planting—Espacement

A suggested objection to eight feet by eight feet, as opposed to six feet by six feet planting in alternate lines was that there would be fewer first-class stems of the main species from which to select trees to be retained for the final crop. The point is worth considering in more detail. It is estimated that if we grow our timber to eighteen inches to twenty-two inches in diameter the final crop will consist of about 115 trees per acre. Let us suppose that we group-plant about twenty per cent of broad-leaved secondary species originally, and retain about fifteen per cent in the final crop, i.e. about 98 Cypress and 17 others in the 115 trees per acre of the final crop. The following table shows the actual number of trees which would be planted per acre at different espacements, under the line-by-line and the group-planting systems.

Espacement method	Total per Acre		
	All species	Cypress	Others
6 ft. × 6 ft. Line ..	1,210	605	605
6 ft. × 6 ft. Groups ..	1,210	968	242
8 ft. × 8 ft. Line ..	680	340	340
8 ft. × 8 ft. Groups ..	680	544	136
9 ft. × 9 ft. Line ..	537	268	268
9 ft. × 9 ft. Groups ..	537	430	107
10 ft. × 10 ft. Line ..	435	217	217
10 ft. × 10 ft. Groups ..	435	348	87

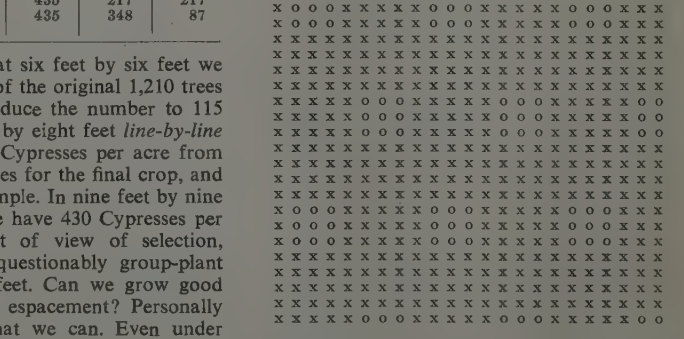
You will note that at six feet by six feet we have to cut out 1,095 of the original 1,210 trees planted in order to reduce the number to 115 per acre. In eight feet by eight feet *line-by-line* planting we have 340 Cypresses per acre from which to choose 98 trees for the final crop, and this I consider to be ample. In nine feet by nine feet *group* planting we have 430 Cypresses per acre. From the point of view of selection, therefore, we can unquestionably group-plant at nine feet by nine feet. Can we grow good Cypress timber at this espacement? Personally I am quite certain that we can. Even under the present Forest Department routine treatment, we cut out large numbers of trees early in the rotation, to give Cypresses more room in which to grow. The core of the log is going to be knotty, and it matters little whether these knots are large or small at this stage. A vigorous, healthy young tree will naturally produce strong branches, but it will also develop a strong root-system, which is of the very greatest importance.

It should be noted, incidentally, that although all trees in each group should consist of one species only, two or more secondary species may be used in making any plantation.

Method of Group-planting

Broadleaf groups should consist of six, nine or even more trees. Nine is probably the most suitable number. In a nine feet by nine feet plantation there should be about twelve groups of nine trees per acre, i.e. 108 trees out of 537 or twenty per cent of the total number. About seventeen per acre will remain on into the final crop, so that in about half the groups only one tree out of the nine originally planted will be kept, while in the other half two trees will be kept.

If groups of six trees are used, there will be eighteen groups per acre, but rather more supervision will be necessary during the planting. In practice mathematical accuracy is quite unnecessary. If nine trees per group are used at nine feet by nine feet there should be about 50 feet between the outer margin, or about 70 feet between the centre trees of groups. If this figure is used as a rough guide a sufficiently even mixture will be obtained. If the "O's" (secondary species) and "X's" (Cypresses) are at nine-foot intervals, this is the sort of pattern one should try to obtain over an acre of land:—



Before we leave the question of the system of planting to be adopted, it is only fair to add that, so far, no ill effects have been

observed by me in pure Cypress plantations. It is, in fact, quite probable that in a well thinned plantation, where there is a strong growth of broad-leafed indigenous undershrubs, soil conditions remain satisfactory; and the stem form in such areas is often better than that in mixed plantations.

Pruning

Our aim is to confine the knotty core of the log to a diameter of less than five inches, and at the same time to manage our thinnings in such a way as to allow the tree to maintain a fairly even rate of growth. From the financial point of view we cannot afford to prune higher up the stem than is necessary, but we also cannot afford to leave a five inch diameter stem unpruned if we hope to obtain a reasonable thickness of clear timber outside the knotty core at this point.

A well-grown eleven-year-old Cypress tree may have a diameter of four inches at a point thirty feet above ground-level. I doubt whether it will pay to prune higher than 28 to 30 feet, which means that as a rule the pruning programme will have to be finished at the latest by the end of the thirteenth year after planting. On first-quality sites this figure may be reduced to the end of the tenth year.

Technically, it is not difficult to prune to forty feet or more up the stem. To justify the operation we must allow the tree to put on an increment of at least four inches of clear timber outside the core of the uppermost portion of the pruned stem, before it is felled. In practice this means that the tree when felled should have a diameter of at least fifteen inches, measured over the bark, at a point twenty-eight to thirty feet above ground-level if that is the height to which we propose to prune it. Given reasonable growing space, a Cypress tree in good soil might reach these dimensions in about forty years; but it is unlikely to do so in a lightly thinned plantation. It should be remembered that although clear knot-free timber will only be obtainable from the pruned portion of the stem, the remainder of the tree will provide knotty timber which will be perfectly suitable for estate use.

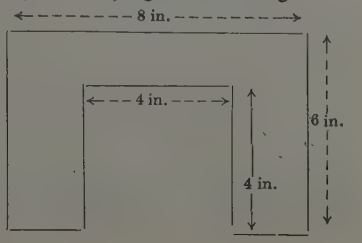
As we propose to rely on artificial pruning in relatively open stands to give us clear timber we must face the fact that our trees, during certain stages of the final prunings, are going to look rather like caricatures. I think that this high pruning does Cypress no harm. To be on the safe side, however, I would recommend that a high pruning should always be preceded by an adequate thinning, so as to allow the crowns of the remaining trees to develop freely and quickly.

Owing to our cheap labour we can undertake more individual operations, per rotation, than is the case in most other countries. Heavy thinnings and prunings at long intervals will induce an uneven rate of growth. Treatment annually might be too expensive to supervise over large areas. It should, however, be possible to treat young plantations every second year during the initial pruning period. At this stage I estimate that Cypress grows nearly five feet a year, under favourable conditions. In young trees the diameter of the stem decreases by about one inch for every ten feet in height. Thus, if we prune a tree to a point where the stem is $3\frac{3}{4}$ in. to 4 in. in diameter, over bark, then the diameter immediately above that point will be nearly $4\frac{1}{4}$ in. to 5 in. two years later, when the next pruning becomes due. But any increment put on over the pruned portion of the stem will consist of knot-free straight-grained timber.

If we prune every third, fourth or fifth year, then we must resign ourselves to having a six- or seven-inch knotty core, or else, at each pruning, we must remove all branches on the stem down to a diameter of two and a half or three inches, which will definitely affect the health and vigour of the tree. In practice it is not always possible to prune even down to four inches diameter, if stem-form is poor with pronounced taper, but in well-grown trees from a good selected seed-strain the trees are smoothly tapered, and enough crown remains after pruning to a point where the stem is no more than four inches in diameter.

Pruning may be done with sharp *pangas*, as close to the stem as possible. A cut must first be made on the bottom side of the branch. This prevents a long strip of bark from being torn from the stem when the branch is cut off from above only. This is important.

A pruning gauge may be constructed very simply out of a piece of one-inch board of some tough timber, eight inches long.



A hole is bored in one corner through which a bit of string can be threaded. This enables the pruner to tie the gauge to his wrist or waist when he is climbing the tree. Each man is provided with a gauge. He makes himself a light ladder, or more usually a notched pole with a fork at the top, and climbs the tree. When he can just fit the gauge over the stem he knows that the diameter at that point is four inches, and he then prunes off all branches below this point, working from the top downward.

All species should be pruned, not only the Cypress.

Basing my figures on such data as I have been able to collect so far, I propose the following as a tentative pruning schedule for *Cupressus lusitanica* and *Cupressus macrocarpa*:—

Age	Height of dominant tree	Prune to height
3	11 feet	5 feet
5	24 ,,	12 ,,
7	35 ,,	18 ,,
9	44 ,,	25 ,,
11	53 ,,	25 to 30 feet

Note that I refer to dominants, from which the final crop will be selected. In poorer land trees will not grow at this rate, but it should be safe to prune, with the gauge, down to four inches diameter every second year. The age and height of trees is merely given as a rough guide as the sequence of operations will depend upon the size of trees in each area. In any case, the gauge cannot be used for the first two prunings as the diameter of the tree will be under four inches at five feet and at twelve feet then.

Thinning

This is a more controversial matter, and in any case as none of our present plantations have run through a full rotation yet, and as all our older areas have been grossly underthinned in the past, and are in consequence smaller in diameter than they should be for their age, we have to rely on a certain amount of intelligent guesswork.

The following schedule, however, should serve as a rough indication of the lines on which to work, with *Cupressus lusitanica* and *Cupressus macrocarpa* planted at nine feet by nine feet.

I would emphasize that this table is only an indication, and that in practice each plantation must be thinned on its own merits. The first thinning at the age of about seven years consists chiefly in the cutting out of dead, dying, and badly deformed or forked stems. In subsequent thinnings many straight, well-formed poles will have to come out. By the time the plantation is fourteen years old thinnings will provide small logs suitable for sawing either by pit-sawyers or on a saw-bench.

Age	Height of dominant	Average number in stand per acre	Thin down to number per acre
Years	*Feet*		
7	35	537	400 to 450
9	44	425	350 to 400
11	53	375	300 to 350
14	66	325	250 to 300
17	79	275	200 to 250
20	92	225	150 to 200
25	112	175	100 to 140

A few hints on the subject of thinning might not be out of place:—

(i) The general idea is to remove certain trees, not necessarily because they are badly shaped or sickly, but mainly in order to give other trees room in which to develop *during the next two or three years.* The thinner must harden his heart and cut out many fine young poles, in a good plantation, if he wants the remainder to do well.

(ii) The crop should always occupy the ground as evenly as possible. This may sometimes mean that a good tree must be cut out, and a rather less good one must be allowed to remain. If only the smallest trees are cut at each thinning, the resulting crop might be distributed unevenly.

(iii) At the same time the thinner should watch the crowns of the trees as much as the stems. It is a cardinal principle to retain, whenever possible, only those trees which are healthy and vigorous with full leafy crowns of a good colour.

(iv) Occasionally one finds a "wolf-tree", i.e. a specimen with unusually thick spreading branches. The diameter of such a tree is often considerably larger than that of the surrounding stems. As a rule it is better to get rid of these individuals as soon as they are recognizable. They take up an undue amount of space and their timber is apt to be of poor quality.

(v) If, by the time an area is due for a thinning, the leaves on the lower branches of the trees are brown, or have already fallen, it is a sure sign that the last thinning was too light.

(vi) In the same way, if, after the plantation is about nine years old, no shrubby under-

growth is coming in, and the soil remains bare, then more trees should come out.

(vii) A plantation, immediately after it has been thinned and pruned, is usually a depressing sight. Put it out of your mind for six months. If it has not been burnt by the end of that period, it will then look normal again, if rains have fallen in the meantime.

(viii) Remember that in thinning fast-growing species like Cypresses it is far more common to under-thin than to over-thin. Unless you have an uneasy feeling, by the time the marked trees have been cut out, that you have irretrievably ruined a promising crop, you have probably under-thinned. It is very unlikely that you will be able to do any permanent harm until you have reduced to at least 250 trees per acre.

(ix) To check your results, select a tree in a stand of average density. Measure off 105 feet down one row or take the distance occupied by twelve trees in the original plantation. Measure off another line of 105 feet from the first tree selected, and at right angles to the first line. These two lines form two sides of a square a quarter of an acre in extent. Complete the square, count the number of stems remaining inside and multiply by four. The result gives the number of trees per acre in the stand.

In (vi) above I mentioned undergrowth. I regard it as a matter of the greatest importance to encourage the establishment of a complete ground cover of indigenous undergrowth—excluding grasses—as soon as the crop is well established and pruning and thinning operations begin. In certain areas, it is true, this may lead to the danger of attacks by bark-eating field rats. For control measures in this event you are referred to Kenya Forest Department Bulletin No. 31 of 1937.

In (vii) above, in the same way, I mentioned fire. It is obvious that special precautions must be taken when quantities of thinnings and prunings are lying on the floor of the plantation.

Tasks

The following are, I think, reasonable tasks for labour:—

Pruning	Trees per man per day
Up ft. to 5 ft.	200
5 ft. to 12 ft.	100
12 ft. to 18 ft.	60
18 ft. to 25 ft.	40
25 ft. to 30 ft.	30

Thinning.—It is more difficult to give tasks here because sometimes the trees are merely cut down and at other times they are cleaned of branches, and brought out to the side of the plantation to be used as poles. Supposing, however, that they are felled, cleaned and left lying in the area for others to collect, then 300, 150, and 80 trees per man per day for 3 in., 6 in. and 8 in. diameter at breast height, respectively, would be reasonable.

Yields

The yield of timber from any area will naturally depend upon:—

(i) The quality of the soil and the state of the plantation, e.g. trees in an area infested with Kikuyu grass will grow very slowly if they ever get away.

(ii) The amount of thinning which has been done. Crowded stands will yield a higher volume of smaller timber than well thinned areas as a rule.

(iii) The length of the rotation.

Assuming that the stand will be cut at the age of about forty to forty-five years then my estimates of yield are:—

	c. ft. per acre
Final crop, say	4,500
Thinnings from the age of 14 onwards	2,500
	7,000

On an average about sixty per cent of the volume of round timber will be recovered in the form of sawn timber. There should also be some hundreds of poles per acre.

These yields will only apply to well-managed plantations in good land, when they will probably be exceeded. Under-thinned, neglected or grass-grown plantations are not uncommon on farms. Even an unpruned log will provide plenty of strong rough timber for estate use, but an under-thinned wood may easily be ruined. Overcrowded trees have poor thin crowns which do not bear a sufficient number of leaves to enable the stem to put on a fair diameter increment. In extreme cases thinnings, even if they are carried out, can do no good as the trees have by then lost their power to put out new branches and recover. And finally, delayed thinnings may result in a crop which is no longer wind-firm, and which may be blown down by the first stiff wind which follows the operation.

GROWING AND CURING FLUE-CURED TOBACCO IN CENTRAL PROVINCE, KENYA

By N. D. Spranger, Agricultural Officer, Kenya

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Flue-cured tobacco production, while not very extensive in Kenya, is meeting with some success in the lower parts of Embu, Fort Hall and Kitui districts. Experimental work on Virginia leaf was first carried out in the short rains season of 1936 when, by invitation of the Department of Agriculture, the British American Tobacco Company sent out one of their leaf specialists, Mr. F. Cooper, to conduct the trials. The initial experiment was carried out in the Gitithi valley in the Embu District at altitudes varying from 4,000 to 4,400 feet above sea-level. The soils in this area are a red loam which flocculates readily on cultivation, and a light red loam. The results of the trial at altitudes of 4,300 feet or less were most satisfactory and after a second and more extensive trial in 1937 the Company decided upon development, later extending the area to the low-lying parts of Embu and Fort Hall districts in and around Sagana. This extension brought in a new soil type, a grey sandy loam which proved equally suitable. In 1938 further successful trials were carried out in the Kitui District.

Before extensive development took place, however, satisfactory agreements were concluded between the Company and native growers, and land for the construction of dwelling houses, barns, grading, bulking and air-curing sheds was made available. By 1941, the Company had erected twelve barns at Sagana, six at Gitithi and six at Kitui and 150 acres were under crop. Growing was extended later to the long-rains season with satisfactory results, except in the Embu and Fort Hall districts where it was found necessary to avoid altitudes of more than 4,100 feet, owing to the incidence of mildew.

The area under flue-cured tobacco in the three districts reached its highest peak in 1942 when 410 acres were planted to the crop, 260 in the Fort Hall-Embu districts and 140 in the Kitui District; this total included a crop in the long and short rains in all districts. The actual yield in cured leaf from this acreage was 186,000 pounds, sufficient material to manufacture sixty million cigarettes. The yield per acre worked out at 528 pounds of all grades of cured leaf, which cannot be considered bad when taking into account the somewhat difficult weather conditions during the short rains and also the fact that the crop was produced by some 1,230 native growers, whose return during each season was just over Sh. 40 per plot of one-third acre.

Experiments were carried out at Makuyu and Kakuzi by the Department of Agriculture in 1939 and 1940 at altitudes varying from 4,400 to 5,000 feet above sea-level. The two main soil types, a light loam and a black sandy loam, proved suitable enough but weather conditions and the incidence of mildew in both seasons were most unsatisfactory with the result that the areas were pronounced unsuitable for the successful growth of Virginia leaf.

In the initial experiments four varieties were tried, namely, Gold Dollar, Cash, White Stem Orinoco and Joyner. Gold Dollar and Cash were grown for some time but at a later date White Stem Orinoco seed from Rhodesia was tried and found so successful that it is now the only variety grown.

Climatic and Soil Conditions

Tobacco should not be grown where hail is prevalent. The crop will grow well on a moderate annual rainfall of 20 to 25 inches; heavy rain during harvest is harmful, the ideal being to have light showers with a high proportion of sunny days. Altitude is an important factor in the production of flue-cured tobacco in the Central Province and has a decided influence on the incidence of mildew. In the short rains 4,300 feet above sea-level is on the danger line, whilst in the long rains the ceiling is reduced to 4,100 feet. Although it has been found that these altitudes cannot be exceeded in the Central Province, this does not mean to say that flue-cured tobacco cannot be grown at higher altitudes in other parts of Kenya. Mount Kenya and the Aberdares may well be the controlling factors in this Province.

The growing of Virginia tobacco should be confined to soils of light texture with a plentiful supply of humus. Heavy soils tend to produce a coarse leaf suitable only for pipe tobacco.

Cultivation in the Nursery

The ideal nursery site should be well drained, protected from the wind and as near as possible to clear running water. The amount of land required for seed beds will depend on the acreage to be planted to tobacco; 250 square yards to every five acres should be ample.

Seed beds should be given their initial cultivation at least three months before sowing, the land being dug to a depth of six to eight inches. A second cultivation will be necessary some two to three weeks before sowing; during this operation the land should be well pulverized after which the seed beds may be pegged out. It will be found most convenient to make the beds four feet wide and sixty feet long, leaving two feet between beds when using a cloth cover and three feet where grass or papyrus is used; this gives an area of twenty square yards for each bed. The beds should be raised three or four inches above the level of the paths. In theory 100 square yards of seed bed sown are sufficient to plant five acres of tobacco; in practice, however, half as much again is usually sown.

Before the seed beds are sown it is essential that they be covered with brushwood and trash to a depth of eighteen inches which is then burnt in order to destroy, as far as possible, all weed seeds, insects or their larvæ as well as fungi. This operation should be carried out eight to ten days before sowing. After burning the beds should be raked over and all bulky material removed whilst the ash can safely be incorporated with the soil.

Shading is the next step and this can be done with papyrus, grass or cheese cloth; in using grass or papyrus the disadvantage is that the beds are open and are thus exposed to insect pest attack. Beds under grass or papyrus should be sown from six to eight days earlier than beds under cheese cloth as germination and growth is slower. All that is necessary for open shade is a stout framework two feet or so in height; the cover, however, should be movable. The grass cover after sowing is fixed to the frame so as to be just clear of the ground, watering being done through the shade; the shade should be raised a foot to eighteen inches soon after germination so as to prevent leggy plants.

The preparation of seed beds under cloth takes much more time but is more satisfactory. The usual method is to drive a line of stakes at five feet intervals down the centre of each bed; stakes an inch in diameter and eighteen inches long will be large enough and they should be driven in firmly leaving six to seven inches of the stake exposed above the level of the bed. Stakes are next driven in lines down the sides of the beds; the same intervals are used but in this case it will only be necessary to expose three to four inches. Wire, 18 to 20 gauge, is now run down each of the lines and attached to the tops of the stakes with a small staple or nail. On completion this should leave a frame of three parallel wires running the length of the bed. The cloth having been cut into requisite lengths is now stretched over the frame and attached with string at several points to the centre wire so as to keep it in position. Each half of the cloth is then stretched over its respective side wire and sticks about a foot long and half an inch in diameter are tied to the edges of the cloth at six to nine inch intervals; these act as weights, keeping the cloth well over the framework and enabling easy manipulation of the cloth when opening or closing the bed before or after watering or weeding. Opening of the cloth to expose the beds will necessarily be frequent. This is done easily by two boys taking the opposite ends of the cloth on the same side, stretching and raising the cloth slightly so as to keep the sticks clear of the side wire and together swinging it up and towards the centre of the bed when the sticks and cloth will come to rest on top of the unexposed half of the cloth. The movement should be quick and smart; when covering the same quick motion is necessary.

Seed for sowing should first be treated with a 0.02 per cent solution of silver nitrate as a disinfectant against possible spread of disease; it should next be put through a mechanical blower to get rid of dirt and light seed. Under cloth, seed is sown six to seven weeks before transplanting is likely to take place. Tobacco seed is very small, one and a quarter level tablespoons being sufficient to plant a hundred square yards of seed bed; if a small measure such as a mustard spoon is available, the quantity of seed required for each bed of twenty square yards can be easily measured by counting the number of level mustard spoons contained in one and a quarter tablespoons and dividing by five if sowing a full bed or by ten if sowing half a bed. Sowing half a bed at a time will be found more satisfactory especially when seeding by means of the watering can.

Two methods of sowing are commonly used, namely, broadcasting and watering. In the broadcasting method, the seed is mixed with ash or maizemeal and the whole broadcast over the bed; the ash or maizemeal indicates the evenness of sowing. In the watering method the seed is put into water in a two-gallon or larger watering can and is sown by "watering" the seed bed. Care must be taken to see that the large rose is on the nozzle of the can; the can should be filled with water and sufficient seed put into it to sow half a bed,

and thoroughly stirred. Then the bed should be quickly "watered" from one end to the other, the spray being directed towards the centre of the bed. After again stirring, "watering" should be continued in the reverse direction, the spray being kept this time towards the edge of the half bed. The process is continued until the water is finished, when the can should be washed once or twice by swirling the water round it, the water then being sprayed on the bed. Finally the rose should be removed and washed. The whole operation must be done quickly and it is surprising how speedily the seed can be sown.

When the beds have had time to dry after sowing, they should be beaten firmly with a flat board, which would conveniently measure nine inches by six inches by one inch. When the beds have been beaten smooth watering can commence, the fine rose now being used.

The beds from now on must be kept damp but not too wet. It is usually necessary to water the beds three times a day until the plants have become well established when two waterings will suffice; when the plants have reached three to four inches in height, one good watering may be sufficient, but this will depend on whether the plants are to be retarded in growth or not. The seedlings must be carefully watched and if they are growing too fast they must be hardened off by exposure to the sun for an hour or more daily and by cutting down watering at the same time. The final hardening-off should commence a week or ten days before transplanting and consists of exposing the seedlings to the sun and increasing the number of hours exposure daily until all shade is removed a few days before transplanting. Seedlings are ready when about six to eight inches in height. A good test is to take a seedling between the thumb and first finger and to bend it until it breaks in the centre; if the break is crisp and clean the seedling is ready.

Troubles in the nursery are not very serious, particularly if the beds are covered, but exposed seed beds are subject to attack by insects. A useful spray, particularly against stem-borer, is a solution of one ounce of arsenate of lead in two gallons of water which is sufficient for a bed of twenty square yards; the spray should be applied weekly.

Seedlings often show poor development and when they are yellowish in colour a cure can usually be effected by watering for five or six consecutive days with a solution of three to four ounces of nitrate of soda or three ounces of sulphate of ammonia dissolved in four gallons of water applied at the rate of four gallons of solution to each bed of twenty square yards. The plants must afterwards be well watered with fresh clean water so as to remove the solution from the leaves, because failure to do this will lead to scorching of the leaves.

Ants sometimes become very destructive on beds and if nothing is done they will eat all the seed. Immediately ants are noticed maize meal or maize husks should be broadcast lightly over the bed, when the ants will usually leave the seeds and tackle the sweeter meal.

Cultivation in the Field

In order to get the best results in the field the land should receive its first ploughing at least six months before planting; ploughing should be six to eight inches deep. A second ploughing will be necessary about two months before planting and during this operation the land should be brought into a fine tilth by means of disc and drag harrows. The object of early preparation of the land is to have the soil thoroughly aerated and as far as possible all grass and plant material decomposed before planting.

Tobacco should not be grown on the same land twice in succession as this will encourage disease and insect pests. The most satisfactory results will be obtained in a three- or four-year rotation. In Rhodesia and South Africa a three-year rotation has proved satisfactory, a green manure being usually included in the rotation.

No experiments have been done locally with manures on tobacco but Bosman and Leppan given the following advice (*Field Crops in South Africa*):—

> "Excessive nitrogen, in the absence of phosphates, gives a coarse dark tobacco, late in maturing, with a tendency to damage by red firey or dead spots here and there on the leaves. A lack of nitrogen gives small and papery leaves, although these may be bright. Potash in the form of nitrate or carbonate gives body to the leaf and improves the burning qualities. On light sandy soils, poor in nitrogen, phosphates must be used with discretion as excessive applications tend to cause premature ripening or firing, especially during dry weather. Manure must be thoroughly rotted before use, as fresh manure produces coarse, heavy tobacco, which has a disagreeable flavour. It should be spread over the land a few months before transplanting and before ploughing."

The land should be pegged before planting takes place, the usual spacing for Virginia tobacco being three feet between the rows and two feet nine inches to three feet between the plants in the row. Holes five to six inches deep are made with a sharp strong stick whilst planting.

The seed beds should be thoroughly soaked before the seedlings are lifted and once lifted the roots must not be exposed to the sun. Cloudy weather is ideal for transplanting; if the sun is hot, planting should not be continued after 10 a.m., but planting in the late afternoon after 3 p.m., can be done if desired. The seedlings should be carted to the field and put under shade. Planters can be fed with seedlings by others or they can collect the seedlings as they require them; whilst transplanting planters must be made to keep the roots covered. Each seedling should be examined before planting, the lower leaves being removed and any damaged roots cut back. If the tap root is too long it can be cut back without doing any harm to the plant. The plant should be lowered into the hole, until not more than an inch of the plant is exposed above ground. Shallow planting is bad as this may lead to the exposure of too much stem to the sun, and the stem being delicate will be scalded and the plant will not develop normally. The plant, having been lowered to a satisfactory depth should be held against the side of the hole while soil is dropped into the hole and packed tightly against the roots. The pressure when firming the soil should be down and across, the aim being to fix the roots firmly against the side of the hole. If this is properly carried out there need be no fear of twisted tap roots or faulty planting.

Three cultivations are usually necessary. The first is a deep cultivation between the rows, which is done soon after planting; the second cultivation is done about three weeks later when the soil should be moved towards the plants in the line; priming, to be mentioned later, is usually commenced at the same time. The third cultivation is given about ten days to a fortnight after the second, the soil again being worked towards the plants. After this operation the plants will be growing in a broad, low ridge and not a high ridge as is usual in earthing-up potatoes.

Priming consists of removing all small leaves from the base of the plant. When the plant has developed, the stem should be left clean for at least six inches above the ground so as to prevent leaves from becoming damaged by contact with the soil; this also permits a free circulation of air. Priming is usually commenced at the second cultivation and continues until the plant is about to flower.

Topping is done soon after the plants come into flower and consists of breaking the stem and removing the flower head. Under normal conditions the flower head is broken off just above one of the narrower top leaves which measures four fingers in width at its widest point. After topping the plant should be left with twelve to fourteen leaves. Once it has been decided to top, the whole crop should be done at the same time.

After topping, strong growing shoots will appear between the stem of the plant and the butts of leaves. These are called suckers and must be removed; inspection and removal should be done at ten-day intervals after topping.

If seed is required, selection of suitable plants should be done before topping, and the heads must be covered with a paper bag as soon as they come into flower. Selected heads will require examination periodically when the head can be suitably thinned and any injurious insects removed.

Harvesting

The leaf starts to ripen soon after topping; at low altitudes in the Central Province this stage is reached some ten days after topping and some nine to ten weeks after planting. Leaves commence ripening from the bottom and when ready to harvest are greenish-yellow.

Picking usually covers a period of six to eight weeks and should be done in the early morning at weekly or ten-day intervals. The leaves are put into baskets or boxes and transported to the barn, and as at no time must the picked leaves be exposed to the sun, some suitable material such as banana leaves or sacking should be used to shade the leaves when picked and whilst in transit, thus keeping them fresh and preventing scorching. It is important to pick mature leaves of uniform colour as this will facilitate curing.

Harvesting should be done in dry weather; light showers will be helpful but heavy rains during picking are bad as these cause regrowth and the leaves lose their yellowish colour, turn a dark green and become glossy. In these circumstances it is necessary to stop picking and to wait until the leaf again turns greenish-yellow; it is impossible, however, after regrowth of this nature to produce the bright lemon-yellow leaf required for cigarette manufacture.

Tying should be done in the shade near the barn. Virginia leaf is usually tied to sticks four feet six inches in length, a piece of string eleven feet in length being attached to one end of each stick. The sticks are put on to a frame or horse three feet high to enable the operator to stand upright whilst tying. One boy does the tying and is assisted by one or two others who arrange the leaves in threes, back to back, and hand them to the tying boy who attaches them to the string with a half-hitch about one inch or so below the butt ends of the leaves. Every alternate group of three is tied on opposite sides of the stick so that when the stick is filled the leaves hang evenly on either side. Sixteen to twenty groups of three leaves are tied to each stick. As the sticks are filled they are taken to the barn where they are hung on barn tiers which are usually four feet wide and twenty feet long, twenty-six to twenty-eight sticks being sufficient for each tier.

Curing

The usual size of curing barns is twenty feet in length, width and height; a barn of this size will hold six to seven thousand pounds of mature leaf and it is designed in such a way as to enable one to control inside temperatures and humidity. The furnace is constructed so as to project well into the barn; a metal flue-pipe is attached to the furnace on the inside and, by the use of T pieces and elbow joints, it is conducted round the barn at one and a half feet from the walls, culminating at a point just above the furnace where it is led out of the barn and into a tall chimney. To control draught and humidity vents are built into the bottom of the barn wall and a further series in the roof. In the case of barns built in Kenya, however, the whole of the top ridging constitutes the top vent which is opened or closed by a long wire attached to a lever on each side of the ridging.

There are usually four stages in curing, namely:—

(*a*) Colouring the leaf;
(*b*) fixing the colour;
(*c*) drying the web;
(*d*) drying the mid-rib.

(*a*) *Colouring the Leaf.*—The aim is to produce a leaf lemon-yellow in colour when cured, and this is done at temperatures varying from 90° to 120° F. After the barn has been filled a small fire is lighted and the temperature of the barn raised to 90° over a period of two to three hours. The barn at this stage must be humid, which it attained by sprinkling water evenly over the floor of the barn with a watering can. The number of gallons to apply will depend on the weather, more water being used on hot cloudless days than on cloudy days; in watering, however, while the floor must be well damped, it must not be made wet. The temperature should remain at 90° until the leaf shows a very decided yellow colour well up from the tip and round the edges of the leaves. This may take from 18 to 24 hours.

When the colouring is developing satisfactorily the temperature should be raised to 95°. At this temperature the humidity must be watched, and one or two waterings may be necessary. The humidity should be such that a torch-glass or spectacles become misty soon after entering. The temperature is kept at 95° until there has again been a decided improvement in colour throughout the leaf, which may take 8 to 24 hours. After this it is raised to 100°, at which temperature no more water should be added, because the leaves should now be losing humidity.

The final process of colouring the leaf requires the temperature to be raised to 125°, and, as this must be done quickly to avoid "sponging", which is caused by moisture not being driven off the surface of the leaf as quickly as it comes out of the leaf, it is necessary to keep the temperature at 100° for three to six hours until it is clear that very little further increase in colour will take place. Then the temperature is raised to 105° when it is wise to open the top vent very slightly. Thereafter the rise in temperature should be quick, not more than two or three hours being allowed at any one stage until 120° is reached. At 110° the top vent should be half opened and the bottom vents just cracked; at 115° the top vent should be fully open and the bottom vents half opened; at 120° the top and bottom vents should be fully open, and the colouring should now be completed.

(*b*) *Fixing the Colour.*—The temperature is now raised from 120° to 125° in two or more hours but it should remain at 125° until the leaf appears dry; this may take six to eight hours, by which time the colour will be fixed.

(*c*) *Drying the Web.*—This is done between the temperatures of 130° and 140° and should be done slowly, the whole period covering twenty to thirty hours. The web should be dried at 135° but the temperature should be held at 140° for several hours to make quite certain.

(*d*) *Drying the Mid-rib.*—After 140° the temperature may be raised fairly quickly, two

hours for each rise of 5° being ample, until 165° is reached; this temperature must be held until the mid-rib has dried out; it may take twenty or more hours. The vents should be half-closed at 145° and at 150° the bottom vent should be closed, but the top vent is left open for a few hours, even after 165° is reached. Leaves from the corners of the barn are used for testing the mid-rib and they must be absolutely dry before the fire is removed. The barn is left closed until temperature falls to 140°, which will give the mid-rib further time to dry out. The barn is then opened up and left for a few hours.

It is important to remember that the early stages of colouring must be done slowly; more leaf has been spoilt by raising temperatures too quickly in the early stages than by doing so too slowly. There is no need to use a wet- and dry-bulb thermometer in curing leaf; a little experience is all that is necessary; the feel and smell of the barn in the early stages being sufficient guides.

DETAILED RECORD OF BRIGHT LIGHT LEAF TYPE CURED AT SAGANA

Day	Time	Temp.	Hours	Vents		Remarks
				Top	Bottom	
1st	3 p.m.	—	3½	closed	closed	Fires started.
	6-30 p.m.	90°	21½	,,	,,	8 gals. water added.
2nd	4 p.m.	95°	9	,,	,,	
3rd	1 a.m.	100°	4½	,,	,,	
	5-30 a.m.	105°	3	cracked	,,	
	8-30 a.m.	110	2½	½ open	cracked	
	11 a.m.	115	3	open	½ open	
	2 p.m.	120	2	,,	open	
	4 p.m.	125	7	,,	,,	
	11 p.m.	130	6	,,	,,	
4th	5 a.m.	135	9	,,	,,	Until web dried.
	2 p.m.	140	6	,,	,,	
	8 p.m.	145	2	½ open	½ open	
	10 p.m.	150	2	,,	closed	
	12 mdnt.	155	2	,,	,,	
5th	2 a.m.	160	2	,,	,,	
	4 a.m.	165	24	closed after 12 hours	—	Until midrib dry.

After the leaf is cured it will be necessary to remove it to a conditioning pit but before doing so it may be necessary to soften the leaf as it will be very brittle. Softening is usually done by passing low-pressure steam through the vents into the barn; after half an hour of steaming the leaf will be sufficiently soft and can then be moved stick by stick into the conditioning pit where it is again hung on tiers. A conditioning pit is an excavation some eight to ten feet below ground-level, roofed over and made weatherproof as well as reasonably air-tight. After filling the conditioning pit with leaf, water is sprinkled on the floor until it is thoroughly wet, usually in the afternoon, and by next morning the leaf will be sufficiently soft and pliable (conditioned) for grading. Tobacco leaf is hygroscopic and readily absorbs moisture.

Grading and Packing

When the leaf is "in condition" it is taken off the sticks and transferred in bulk to the grading shed, which is usually kept humid by sprinkling water on the floor and shutting the doors to prevent the leaf from drying-out too quickly whilst being sorted. Grading is usually done by task work and a good average grader should be able to handle fifty pounds of Virginia leaf a day when once he understands the work. At the Sagana and Kitui Centres nine grades are used but the most important of these are: (*a*) Brights; (*b*) Medium brights; (*c*) Medium dark; (*d*) Dark.

After grading, the leaves are tied into "hands"; or bundles consisting of ten to fifteen leaves of any one grade tied together at the butt ends with a binder leaf of the same grade; the binder is a small leaf folded backwards and inwards to form a ribbon about half-an-inch wide and rolled neatly round the butts, the end being tucked between the leaves. Before baling care must be taken to see that the leaf does not contain too much moisture. This may be tested by holding a hand or two upright, when,

if the leaves remain in that position, the leaf will be in a suitable condition to bale; but if they bend over further drying will be necessary before baling.

Special boxes are required for baling, the standard inside measurements of which are 36 in. by 36 in. by 24 in., the boxes are made in such a way that the sides can easily be removed whilst the top and bottom can be kept in position by clamps after the tobacco has been pressed firmly into the box. The lid of the box is made so as to slip into the box as pressure is being applied. In Kenya bales are usually wrapped in hessian. In preparing a bale, the four sides and the bottom of the box are fitted together but a layer of hessian 60 in. by 45 in. is put on the bottom before it is put into position. The box is then packed with leaf, the butt ends being kept towards the narrow ends of the box. In packing, the leaf must be pressed firmly into position and the corners must be filled properly for this will strengthen the bale. When the box is filled another layer of hessian 60 in. by 45 in. is put over the top of the tobacco, the lid is fitted into position over the hessian and the box is then ready for the press.

The press is a simple one and consists of two stout uprights firmly embedded in the ground with concrete. A very strong beam is then fitted to the uprights and attached to the centre of the beam is an inverted lorry jack. Pressure is now applied until the height of the bale is seventeen inches; this gives a bale 36 in. by 17 in. by 24 in., which should weigh about 200 pounds. Whilst the bale is still under pressure the sides of the box are removed and the clamps, usually four in number, are applied to top and bottom; the pressure is then released and the bale removed for sewing, which is done by unfolding the hessian top and bottom and sewing the pieces neatly together round the centre of the bale. When this has been done the clamps can be removed and the bale is ready for dispatch.

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YOU HAVE BEEN WARNED

Experience on some of the stations has served to emphasize in very striking manner that, in the climate and on the normal soils of Malaya, it is impossible to maintain fertility if the land is used continuously for short-term crops without frequent generous applications of farmyard manure or some similar substitute. Chinese market gardens are the only instance where short-term crops are grown continuously and receive applications of organic manures on such a copious scale as can only be considered for garden or market crops and is beyond economic possibilities of most short-term agricultural crops.

When the Agricultural Stations were first commenced the general lay-out adopted was to set aside a portion for short-term crops, reserving the remainder of the station for a number of permanent tree crops considered most desirable for trial at the station concerned. Although this uniformity in general lay-out had obvious advantages it was realized that the annual crop area, as it was generally termed, might produce difficulties. Accordingly experiments were laid down at a large number of stations designed to throw light on maintaining fertility under conditions of short-term cropping. The results of these and other experiments have made it quite clear that under Malayan conditions it is a matter of very special difficulty to maintain fertility on land if short term crops are continuously grown. So far, no fully satisfactory solution has been found except under the intensive methods of manuring indicated in the preceding paragraph.

Under the conditions detailed and in the light of present knowledge it is perhaps not surprising that on many of the stations the "annual crop" area is now of such poor fertility that special measures will be required to bring the land into a state capable of satisfactorily maintaining even a tree crop. On some stations the tendency was realized sufficiently early to arrest in time the damage being done, by providing for a rotation with suitable green dressings on a scale and for a duration which would most probably be uneconomic in general agricultural practice.

Annual Report on the Departments of Agriculture, Malaya, for the year 1938. paras. 232-234.

UGANDA PLANT DISEASES

By C. G. Hansford, Plant Pathologist, Uganda

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II—DISEASES OF BANANAS

By far the most important disease of bananas in Uganda is the present neglect of the crop. In the past the tending of the banana fields was the work of the women, but with the advent of cash crops such as cotton and coffee, and the great change in the economic condition of the peasant cultivator, the banana gardens have been neglected to pay more attention to these cash crops. The ultimate result is now becoming apparent in the rapid replacement of the banana as the major food crop of the Baganda by the sweet potato, especially in the area within twenty or thirty miles of Kampala. The banana fields remaining in this district are in very poor condition and are likely to deteriorate further to practically complete extinction.

Many reasons are given by the natives for this radical change in their agriculture and diet; among these are the increasing damage caused by the Banana Borer (*Cosmopolites sordidus*), the subdivision of individual holdings below the economic size and below the level of self-sufficiency, and the increasing prevalence of thieves, who cause great loss of bananas, while not taking the trouble to dig up sweet potatoes. From the standpoint of land utilization and conservation of the fertility of the soil, there is no doubt that the change from the permanent banana gardens to an annual crop such as the sweet potato is a very retrograde step, and measures are urgently needed to check it and to return to former practice. For this, extensive replanting of the banana fields is required, coupled with adequate cleaning from weeds, especially the eradication of "lumbugu" (*Digitaria scalarum*) from the fields. Recent plantings have not been deep enough, with the result that the stools after a few years become perched upon mounds separated by erosion gullies and bare soil, due to lack of mulch from the old leaves and stems of the crop. New fields should be planted 18 to 24 inches deep, and mulched with any refuse available, until the time when sufficient mulch can be obtained from the crop itself. Another most important measure, long completely neglected, is the cutting down of the stems which have fruited, and splitting these into single layers for use as mulch. These old stems must be removed completely to below ground level after fruiting, and the remains of the hard "bulb" should be covered with two or three inches of soil. Such measures leave no half dead soft tissues to act as breeding places for *Cosmopolites*, while the mulch from the split stems encourages the increase of the predators of this pest. The development of suckers from the stools should be controlled to give a regular succession of fruiting stems, and though local requirements of bananas purely for food purposes are less exacting than the market demands in the West Indies, there is no doubt that some degree of control of sucker development is beneficial in the early stages of new fields.

An important consideration in banana cultivation is the very pronounced "edge effect", due partly to exposure to drying winds, as well as to competition with weeds from surrounding grasslands. This "edge effect" can be reduced in two ways, either by planting windbreaks and scattered trees in the banana field, preferably the barkcloth trees (*Ficus* spp.), as was usual under primitive conditions, or by planting the crop on a co-operative basis in large solid blocks. The more adverse general soil and climatic conditions may be in any given area, the more important it is to pay attention to these matters, An instance of very successful planting of bananas in a difficult area is afforded by the cultivation of this crop at Serere in Teso, where a few Baganda immigrants commenced its cultivation in 1923-26. At that time the gardens were only a few acres in extent and looked very miserable, the plants obviously having a very difficult struggle for existence. Since that time the fields have been extended until to-day they cover several hundreds of acres, and the growth and production from this almost solid block has been very satisfactory.

In such areas, liable to annual periods of drought accompanied by hot drying winds, the banana cannot be expected to replace entirely the other food crops, such as sweet potato and *Eleusine*, but for at least half the year the banana should provide the major food requirements, and even a surplus which can be made into banana flour for storage against the annual dry season. Competent observers agree that while *Cosmopolites* is capable of causing severe damage in these areas, it can be controlled very efficiently, by good cultivation practice, to a point at which its damage is very small.

During the last fifteen years there has been a distinct tendency on the part of native cultivators in such dry areas of Uganda as Teso, Bugwere and Ankole to increase the planting of bananas, in marked contrast to the Kampala area, where the crop is fast disappearing, though climatic conditions in the latter are far more favourable. In the writer's view the success of the crop in the more difficult areas is due to the greater care given to its cultivation, as the natives know that unless it is carefully tended it will fail completely, whereas there appears to be an attitude in the more favoured areas that the crop will grow itself. Around Kampala the breaking up of the old, almost continuous, sheets of bananas into isolated diminutive holdings, coupled with the destruction of almost every tree and patch of forest, has resulted in increased exposure to wind and drought; in addition most of the remaining fields are old, containing large clumps of bananas usually much above ground level, and separated by gullies and bare soil, so that the plants are now living under much drier conditions than in the past. The final result, only to be expected in such a case, has been the drop in yield to a point at which the fields can no longer support the population, and the replacement of the crop by another, which may be able to stand up better to almost complete neglect.

The replacement crop has usually been the sweet potato, and as mentioned in the first article of this series, this is now becoming affected by a virus disease, which may have serious effects on production, though it is still too early to give even a rough estimate of its damage.

To sum up, provided that sufficient care in cultivation is given the banana fields, the damage caused by the diseases listed below is usually negligible.

Stem Rot (*Marasmius semiustus*)

This disease is of occasional occurrence in various parts of Uganda, and probably exists wherever the crop is grown; it is usually associated with gravelly soils under conditions of neglect of cultivation, accentuated by long periods of drought. Weeds and grass between the plants increase the liability to attack.

Compared with healthy plants close by, affected stools show the effect of drought more plainly, in that the leaves dry up more rapidly until only two or three remain. This drying of the plant extends downwards into the trunk, where the outer sheaths turn brown to grey and adhere closely to the inner layers. Towards the base the outer sheaths are moist and soft, more or less rotten and often contain strands of white mycelium. On removal of the outer sheaths, white surface patches of mycelium may appear on those next below, often surrounded by oval brown margins, indicating where the fungus has penetrated further. In wet weather the pale yellowish mushrooms of the fungus may appear on the outside of the plant near ground level, but these are rare in Uganda.

The roots are also attacked and collapse, while the fungus passes from them into the "bulb", though the harder tissues of the latter are rarely invaded. In late stages of infection the whole plant is often blown over by wind, owing to the death of most of the roots.

Affected stools should be dug out completely and cut into small pieces for use as mulch in the field; the pieces should not be thicker than a single leaf sheath, otherwise the fungus may utilize them as food and from them may spread to other plants. Coupled with this destruction of the affected stools, the whole field should be thoroughly cultivated and mulched, and weeds should be eradicated. Provided sufficient attention is given to the fields, the disease should not reappear.

Stem Rot (*Armillaria mellea*)

Plants attacked by this fungus show symptoms much like those described above for *Marasmius* disease, but *Armillaria* attacks the tissues of the "bulb". When this is cut across, it shows white strands or pockets of mycelium, surrounded by dark lines, and with neighbouring parts of the tissues dark brown to reddish; the whole affected bulb has a pronounced "mushroom" smell. In Uganda the disease is only occasional, and usually associated with the presence of rotting tree stumps or large roots in the soil. Bad drainage is often a contributory cause. Affected plants should be dug out completely, cut into thin slices and spread over the ground; the holes from which they have been removed should be opened out and exposed to the sun for a few months after which it is usually safe to replant with healthy suckers. A search should be made for old tree stumps or roots close by, and these removed completely for firewood.

Leaf Spot Diseases

Cercospora musae occurs fairly commonly in Uganda around Lake Victoria, but no instances of severe damage, even on individual

plants, have yet been noticed. In other banana-growing countries this disease has become of great importance; it still remains doubtful whether the Uganda fungus is truly identical with that in the West Indies or whether it is merely a less pathogenic strain. It is possible that our Uganda banana varieties have a greater resistance to attack. Here the fungus causes at first light brownish-green lines parallel to the leaf veins, later widening into elliptic pale grey-brown spots surrounded by a dark-brown margin. Only on old leaves and near their margins do these spots show any tendency to coalesce to form dead patches, and no rapid destruction of the leaves has yet been found in Uganda.

Helminthosporium torulosum causes a dark brown to almost black lenticular leafspot, usually more numerous towards the edge of the leaf, and often surrounded by a bright yellow zone. In severe attacks each spot may be at the base of a wedge of dried-out tissue extending to the leaf edge, or these wedges may unite to form a more or less continuous band of dry, light brown tissue around the whole leaf. No extension of the attack to the petiole or leaf base has been recorded in Uganda, where the disease is limited to the older leaves of the plant and does not appear to cause any damage to the crop, except in the very rare instances where the fruit itself is attacked and develops a "black tip" disease.

Helminthosporium musae-sapientum causes dark-brown leafspots with a grey centre, oval, elongated parallel to the lateral veins of the leaf, one-half to three-quarters of an inch long, often confluent and indistinctly zoned with darker lines. The fungus fruits on both surfaces of the leafspot and in moist weather forms a greenish-black mould on it. The disease is not serious and the fungus has not been found to attack other parts of the plant.

Fruit Rot

Most of the bananas cultivated in Uganda are cut when still green, and used for cooking; in consequence the various rots of the fruit and its stem described from other countries are of no importance here, as they attack the fruit at a late stage in its ripening. It is only in fruit of certain varieties grown for sale in the markets to non-natives that such fruit rots occur in Uganda, and even on such fruit the rots are uncommon, unless the bananas have been bruised or damaged, or have been stored until somewhat over-ripe. The following fruit rots occur here:

Gloeosporium musarum, Botryodiplodia theobromae, Thielaviopsis paradoxa, Fusarium moniliforme, Acrothecium lunatum, with a large number of other fungi secondary upon either damaged fruit, or those attacked by one of the above.

III—DISEASES OF CASSAVA

Mosaic Disease

The chief symptom of this disease is the distortion of the leaves of affected plants, accompanied by a mottling of light and dark green areas between the veins. Affected plants make slower growth than healthy plants near by, and the crop production is affected to a serious extent. The disease now occurs everywhere in Uganda, and its incidence in individual plots has greatly increased during the past twenty years. In some districts, especially in the north and east of Uganda, it is now particularly severe and has reached the point at which it is hardly possible to continue the cultivation of susceptible varieties of the crop. In several other districts this point is rapidly being approached.

Fortunately, with the co-operation of the Amani Institute we have now been able to secure a number of new varieties of the crop which are very resistant to attack, and these are now being propagated as fast as possible for introduction into general cultivation and to replace the old varieties. An account of this work is being prepared for publication by the Botanical staff of the Department of Agriculture.

Leaf Spot Diseases

That due to *Cercospora henningsii* occurs in Uganda wherever cassava is grown, and is usually limited to the older leaves of the plants, which turn pale green or yellow and each have a number of rounded or angular greenish-brown spots about half an inch in diameter; later these spots turn pale brown and dry out, being covered on the lower surface with a thin grey mould of the spores of the fungus. There is evidence that some varieties of cassava are more susceptible to attack than are others, but no instance of severe damage to the crop has yet been reported, so that the disease, though unsightly, is of no economic importance.

Another leaf spot, due to *Bacterium cassavae,* occurs in Uganda, but most of the varieties in common cultivation appear to be immune to its attack. On susceptible varieties the

bacterium causes small angular spots on the leaves, at first dark green and wet in appearance, later turning dark brown and drying out; the whole appearance is very similar to that of Black Arm on cotton. In some cases the bacterium spreads from the leaf-blade through the petiole into the stem, where it causes a wet lesion, often covered with a yellow gummy layer of bacteria. All varieties known to be susceptible to attack by this bacterium have also proved susceptible to Mosaic Disease, so that they will soon disappear from cultivation as they are replaced by others resistant to Mosaic. Whether any of the new varieties of the latter class are susceptible to the bacterium is not yet known.

Wilt Disease

Hitherto cases of attack by the cotton wilt fungus, *Verticillium dahliae*, have been reported on cassava only at Bukalasa. It is likely that occasional plants may be attacked in native cultivation, but are not yet numerous enough to have been noticed and reported. Cassava plants appear to be most susceptible to attack by this fungus during the first two months after planting; if they escape infection at this stage there is little risk of attack later, and as a whole the cassava crop is much more resistant to infection than cotton. No cases of severe attack on individual plots have yet been reported in Uganda. Affected plants show a gradual, or in some individuals, a sudden wilting of the foliage, by which time the whole plant is permeated by the fungus, as shown by dark streaks in the stem and roots. Such plants usually die completely, so that there is little risk of spreading the disease by planting infected cuttings. The attacks so far found in Uganda are on such a small scale that it has not yet been possible to accumulate field notes on the relative resistance or susceptible varieties of the crop.

Tuber Rots

On occasional plants a rot due to attack by *Armillaria mellea* has been found. This fungus causes a rather dry rot, with often black threads on the surface of the roots and sometimes patches of white mycelium surrounded by black lines inside the tissues. The affected tissues usually have a pronounced "mushroom" smell. In all cases seen the disease has been limited to single plants and probably the spread from plant to plant is too slow to cause severe damage to the crop before it is ready for harvest.

Recently a single instance of a disease of tubers and roots caused by a purple-brown mycelium, probably belonging to a species of *Helicobasidium*, has been recorded. The mycelium formed a loose coating of single interwoven hyphae or loose strands over the surface of the base of the plant at ground level and below, with penetration into the outer layers of the roots, causing a dry hard rot.

At least two other rots of cassava tubers are known in Uganda, but so far the fungi associated with these have not been induced to fruit, either on the infected roots or in artificial culture, so that they are still unidentified.

During the droughts of the last two years a considerable proportion of tubers found in native markets around Kampala have shown dark streaks and flecks distributed generally through the tissues, not bearing any definite relation to the vascular system. No fungus or bacterium has been found in these dark streaks, and it is possible that the disease may be a result of infection by mosaic. No evidence has yet been obtained of the existence in Uganda of the "Brown Streak" virus disease of cassava, described by Storey as occurring in the coast districts of Tanganyika.

IV—DISEASES OF SWEET POTATO

Virus Disease

This has been described in the first article of this series. Since that account was written, the writer has paid a visit to the Mulungu Experiment Station of INEAC, Kivu, Belgian Congo, to discuss the problem with the workers there, and arrangements have been made for collaborative research into all its aspects.

The symptoms shown by the disease in Kivu and Ruanda are in some respects different from those so far found at Kawanda in Uganda: affected plants of most varieties in the former area, as well as in the districts of Ankole and Kigezi in Uganda, show dark-brown, slightly sunken areas or lines between the main veins of the leaves. This appearance is designated "bronzing", and is distinct from the development of indistinct purple discoloration shown by many varieties both in Kivu and at Kawanda, for which the term "pigmentation" is reserved. At Kawanda certain varieties show a very severe "rosette" appearance, accompanied by a general pale yellowish-green coloration of the whole plants, visible from a distance; this symptom was not common at Mulungu.

Whether these differences are due to climatic and soil effects or whether they are caused by different combinations of more than one virus, is not yet known. The remaining symptoms described in No. 1 of this series, are common to all areas where we have examined diseased plants.

A peculiar symptom shown in some areas, but not yet definitely related to virus infection, is the development of dense coats of long white or pale yellow hairs on the younger parts of the plants, while the older leaves and stems appear normal. This was noticed particularly on a plot of mixed varieties in Ankole; all varieties in the plot showed this appearance, and on many it was accompanied by a definite thickening of the younger parts of the stems, but with no pronounced shortening of the internodes and thus no "rosette".

At Mulungu, in spite of a very large planting of seeds collected from native varieties of the crop, hitherto no seedling has been found immune to attack, though it is still much too early to determine whether any are capable of producing a reasonable crop in spite of being infected, that is, whether any are "tolerant" of the disease. Two wild types of *Ipomoea*, collected from the bush at Mulungu, have proved susceptible to the virus, and one shows rather severe infection.

Stem Disease (*Plenodomus destruens*)

This commences as small brown to black spots on the stem surface, and later extends until the stem is completely girdled at soil level, or further along the vines; the blackened areas may be continuous or broken up into individual spots scattered along the vines. The tissues of the affected parts are hard and dry on the surface, but usually limited to the exterior part of the stem, which becomes brittle and is easily broken off at the point of infection. Though there seems to be no penetration by the fungus into the deeper layers of the stem, in severe infections the distal parts of the vines make little growth unless they are able to form new roots beyond the point of attack.

The native varieties of the crop show usually considerable resistance to this disease, but some are known to be much more susceptible, and form little or no crop when severely affected. The disease is known to occur in Ankole, Kigezi, Toro and Mengo districts of Uganda, and is probably of much more general distribution, though as a rule damage is very small save on varieties especially susceptible. In a recent trial at Kawanda one of the latter showed every plant severely affected while other varieties adjoining exhibited mere traces of infection. The disease was found in Kivu and Ruanda-Urundi districts of the Belgian Congo on our recent visit, and in one area of Ankole District of Uganda almost every plot of sweet potatoes showed severe infection on all varieties; in the latter case the incidence of the disease may have been accentuated by the long drought.

Charcoal Rot (*Rhizoctonia bataticola*)

As a general rule this disease in Uganda is limited to occasional tubers on scattered plants and general attack on the whole crop of an individual plant appears to be rare. Infection of other parts of the sweet potato plant has not been observed in Uganda. The soil conditions predisposing to attack of the tubers are not known; it is probable that the fungus enters direct from the soil, as it is of wide distribution in all Uganda soils, and has a large range of host plants. The infected tubers show a hard dry black rot, starting from one side or from one end, and soon extending throughout the tuber.

Only one case of the tuber rot due to *Pythium* sp. has so far been recorded in Uganda, so that this remains a scientific curiosity; the fungus caused a soft watery rot of the whole surface layers of the infected tuber.

Leaf Spot (*Cercospora* sp.)

This is of common occurrence on most varieties of sweet potato grown at Kawanda, though no effect upon growth of the plants or upon tuber formation results; the leafspots are up to nearly one inch in diameter, brown, dry, rounded to irregular in shape, and often breaking up and falling out of the leaf. No other fungi have been found atacking the leaves of the crop in Uganda, though there are a fair number of parasitic fungi common on wild species of *Ipomoea* occurring here.

All the very finest original pictures, and the topping things in Nature, have a certain quaintness by which they partly affect us; not the quaintness of bungling—the queer doings of a common thought; but a curiousness in their beauty, a salt on their tails, by which the imagination catches hold on them.

Samuel Palmer quoted by Geoffrey Grigson.

THE FEEDING OF POULTRY WHEN NORMAL FOODS ARE SCARCE

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Introduction

In this Territory poultry are kept under four, very different, systems of management: (*a*) the native system whereby the birds fend for themselves; (*b*) the farmyard system, in which the fowls are expected to find the major part of their diet but are given some grains or mashes; (*c*) the back-yard system, when kitchen and garden scraps are fed together with grains and mashes; and (*d*) the intensive system, where the birds are confined to grass runs and fed balanced rations adjusted to their productive capacity. The principles underlying the computation of scientifically designed poultry rations have already been published locally [1] and that bulletin provides the essential data for those who wish to alter or adjust their present systems of feeding. Only a summary of the production and maintenance requirements of fowls will be given in this paper.

Since the outbreak of war, military demands, decreased cereal imports and the effect of drought on local production have combined to produce a shortage of staple poultry foods so that many people have sought additional advice because they are unable to purchase the poultry foods they desire and, at times, have been unable to get enough of any feeding stuff suitable for fowls. In this Territory, maize and millets form the staple grains fed to poultry, but the demands for these for human consumption has made it most difficult to obtain supplies. Wheat bran, which is another commonly used poultry food, has been in extremely short supply because (1) the shortage of flour made it desirable to include wheaten offals in the standard flour, and (2) the reduced quantity available has been used for feeding pigs. Rice polishings and brans have been very scarce owing to adverse climatic interference with the production of rice, coupled with the need to reserve some of these products for feeding pigs and dairy cows. Oil cakes have been in great demand for cows and pigs, so that poultry have had to go without to a large extent. Potatoes, which are the best substitute for cereals have been unobtainable in sufficient quantities to meet human needs and so have not been available for poultry. Meat meal has been reserved to a large extent for pigs, because drought by closing stock routes forced the local meat factory to cease production for months on end, with the result that poultry feeders have been unable to purchase this very desirable source of animal protein. Poultry keepers have thus had a difficult task to feed their flocks suitable or economic rations.

The object of this article is to direct the attention of small poultry-keepers to other local sources of foods and to indicate how the present level of poultry nutrition can be improved.

Before dealing with these matters there is one important question of poultry policy which needs consideration, namely, what should a poultry keeper do if suitable foods are quite impossible to obtain in sufficient quantities to feed his flock? Is he to reduce the numbers of his flock or is he to put his birds on short rations? Disregarding entirely the breeder of high-class birds, who relies for his living on the sale of birds rather than of eggs, and considering only the poultry keeper who feeds his birds entirely for egg production, recent work [2] throws some interesting light on this problem. In an experiment where comparable lots of birds were fed on restricted rations, it was found that no reduction took place in the weight of the birds nor in the average egg-weight when the amounts fed were 75 per cent or 87.5 per cent of the full ration given to a third group of birds. On the other hand, on these reduced food-intakes the eggs produced were only 46 per cent and 69 per cent of those from the properly fed third pen. In this experiment the quality of the ration was the same for each pen, only the quantity was altered, but it is seen that a reduction of 25 per cent in the amount of food fed more than doubled the cost of the eggs. If, in addition to restricting the quantity of food, it is also necessary to reduce the quality owing to limitation of supplies, an even more serious decrease in egg yields and increase in production costs would take place. It would be unwise to attempt to answer this question of policy in general terms but individual poultry-keepers can decide their own policy in the light of the above taking into consideration the price at which eggs are sold or whether the object is to produce eggs for their own consumption irrespective of cost.

In pre-war days the locally available poultry foods were maize, millets, tail-wheat, broken rice, rice dust (polishings and bran with some glumes as contaminants), maize and wheat brans, groundnut cakes, beans, cowpeas, meat meal, bone meal, separated milk and green foods. When food is short the following foodstuffs should be used as far as possible or necessary: buckwheat, sunflower seeds, potato peelings, kitchen and hotel swill, residues from fish trades, shell-fish flesh, meat and blood waste from slaughter houses, *young* lawn clippings, vegetable waste, buttermilk, whey, coconut cake, molasses, sweepings from cereal mills and godowns, barley, oats, and the grain residues from the making of beer. The following notes on these foods are intended to indicate their more important characters:—

Barley.—Many farmers do not grow barley because their arable land is devoted to more important human grains such as wheat or maize, whilst most barley produced locally is either sold to breweries or fed to pigs. During the present cereal shortage more barley could be grown and some could be incorporated in poultry rations. There is an old prejudice against barley for fowls in that it is reputed to produce fatty livers, but this only happens when it is fed in large amounts in unbalanced rations. Used in small amounts in properly designed rations it can be very valuable. Barley should always be ground before being fed to fowls.

Buckwheat.—In pre-war days small patches of buckwheat were often grown by farmers to attract partridges and other game birds to the farm. It is not a crop to grow in large amounts because other cereals, with higher feeding values, will usually give greater yields per acre and, as the grain does not ripen all at the same time, the crop must be picked over several times to get the maximum yield. The grain must always be crushed before feeding to poultry because the unbroken hard black seed-coat is not very digestible and may cause the endosperm to be inefficiently utilized if the uncrushed seed coat hinders penetration of digestive enzymes. As it can be grown on odd patches which are inconvenient for the main cereal crops, or where the first cereal planting has failed, it can form a useful minor constituent of poultry rations, but its feeding value is below that of the other cereals.

Oats.—This is another cereal crop not grown extensively in this Territory and when grown is usually specially for horses. It is the most fibrous of the cereal grains and often, in this Territory, the grains fail to fill out properly so that their fibrous character is exaggerated. Provided oats are ground they can be fed to poultry with very successful results.

Sweepings from cereal mills and godowns.—The sweepings from mills and godowns naturally contain dirt and other substances of no feeding value, but the presence of large amounts of maize, millet, wheat or rice grains makes them extremely valuable in these days of short supplies. The quantity available is not large and the feeding value will tend to vary with the proportions of the various cereals present but sweepings from a convenient source of the grain part of the ration.

Grain residues from the making of beer.—When purchased from a brewery or native *pombe* house, these grain residues are very wet and ferment quickly, so that it is advisable to spread them out immediately to dry in the sun. When dried, these residues will keep for as long as other cereal by-products. The wet grains could be used to make wet mashes, but it is recommended that the grains be dried and the residues then used in the same way as other cereal by-products. According to the efficiency of the beer-making process, dried grains vary in composition, those from breweries being more fibrous and richer in protein than wheat bran, whilst those from native *pombe* preparation may be very little different in composition from the original grain. Because of the possibility of high fibre-content they should not form more than 20 per cent of the total ration for fowls.

Sunflower seeds.—Sunflowers are grown in certain countries for the oil contained in the seeds and the residues are then used as a cake for live stock. In this Territory it is possible that the seeds could form a useful feed for poultry during the present shortage of the more staple foods, but they should not be fed in large quantities (i.e. not more than 1 oz. daily to every five birds). The seed hulls are very fibrous and will detract from the feeding value of the seeds unless removed.

Job's Tears (*Coix Lachryma Jobi*).—This plant, which is fairly common in wet places, especially near the coast, developes hard fibrous "seeds" slightly bigger than peas. The "seed" consists of a small grain enclosed in a fibrous matrix. A hard, shiny, coat forms on the outside of the fibrous covering to give the "seeds" a pearl-like lustre and their popular

name. These "seeds", mixed with cake, have formed the basal part of poultry rations at Amani for some time and can be said to have kept the Amani flocks during the recent food shortages. As other poultry keepers may wish to feed these "seeds" the following figures were obtained to show the compositions of "seeds" which (*a*) had not formed hard pearly coatings and (*b*) had formed a hard outer coat. Although figures are on record showing the composition of the central grain after removal from its fibrous and silicious coats, I know of no record of the compositions of whole "seeds" (including grain, fibrous and silicious coatings).

Composition of Job's Tears

	"Seeds" without a pearly coat	"Seeds" with a pearly coat
	Per cent	*Per cent*
Crude protein	9·62	5·86
Ether extract	4·37	3·36
N-free extract	27·61	11·40
Crude fibre	41·73	55·53
Total ash	6·15	14·58
Insoluble ash	5·13	13·13
Soluble ash	1·02	1·45
Moisture	10·52	9·27

As would be expected from their appearance, the quantity of fibre is very high but, when mixed with cake to provide extra protein, the fact remains that these "seeds" have proved extremely useful at a time when cereals were unobtainable.

Coco-nut cake.—This cake, which has a much lower feeding value than simsim or groundnut cakes because of its much lower digestible protein content and its more fibrous nature, can play a useful part in poultry diets. It is a palatable food but must be fed correctly. It should be broken into small pieces before mixing with the other constituents of poultry mashes.

Whey.—This by-product of cheese-making can be fed to poultry either as a liquid instead of water or in a mash. It is not so valuable as separated milk but is nevertheless a useful source of the small amount of animal protein which makes such a great difference to the feeding-value of poultry foods.

Buttermilk.—Buttermilk can be used in the same way as whey, but is a much better feeding-stuff and closely resembles separated milk in feeding value. It is much more commonly available than whey, is palatable, and increases the nutritive value of a mixed ration.

Molasses.—Large quantities of molasses are produced by local sugar factories but very little is used for stock feeding. It is well liked by poultry and makes other foods more palatable. It supplies very little protein, but about 50-60 per cent of its weight consists of carbohydrates. It is best to dilute it with one or two times its volume of water before use as it is then much more easy to incorporate in mashes. This foodstuff, largely going to waste at the moment, should be used to a much greater extent during shortages of carbonaceous feeding stuffs.

Vegetable waste.—All vegetable waste such as cabbage, spinach and lettuce leaves, carrot tops, etc., could be given to poultry. If desired they can be chopped and incorporated with the mash but this is not necessary. In addition, peelings from turnips and other roots could also be fed, but these are probably better utilized if cooked and then incorporated in the mash.

Swill.—All kitchen waste, consisting of bread, crumbs, meat scraps, soup and vegetable residues should be fed to poultry. They can either be steamed and fed warm as part of a warm mash mixed with cereal by-products, or fed cold on their own or mixed with other foods. Large amounts of kitchen waste from hotels, camps and townships are wasted, but this swill could serve a very useful purpose in augmenting poultry rations. Hotel and camp swill must be examined for harmful constituents such as razor-blades, etc., and should always be boiled before feeding. The composition is most variable and no general rules can be followed in its use; some people prefer to strain off the water and boil the solid residues with other foodstuffs to make a mash, whilst others use the dilute swill for mixing their mashes.

Slaughter-house waste products.—Condemned carcasses are always boiled in Government abattoirs and such boiled meat forms a useful poultry food when minced. The soup left after boiling condemned carcasses is also a useful food and can be used to mix mashes. If boiled daily, it will keep for many days, but any thick layer of fat should be skimmed off before feeding to fowls. Lungs, spleen, genital organs, and muzzles of slaughtered animals can be purchased cheaply, boiled and minced to make very useful protein supplements, and in times of desperation meat, liver or heart can be purchased for feeding but this increases the cost of the rations. Blood can be utilized in a

variety of ways, the best of which is probably to collect it as it is shed and stir steadily with a bunch of twigs or the hand to remove fibrin threads. The resulting defibrinated blood will not clot and can be taken home and mixed with rice dust or brans in the proportions of ten parts of bran or rice dust to seven parts of blood. This mixture can either be fed wet the same day or dried in the sun and stored for use as required. If blood cannot be collected as it is shed, the clotted blood should be collected, broken into small pieces and poured slowly into its own volume of boiling water. The resulting liver-coloured "porridge" can then be used to mix up mash mixtures for feeding the same day. Such coagulated blood cannot be stored owing to the rapidity with which it putrefies.

Residues from fish industries.—Heads, "insides" and other scraps from the native fishing industries can be boiled, minced and mixed with cereal by-products to form a mash.

Shell-fish flesh.—An article published recently in England [3] described how poultry food can be obtained from mussels, cockles, winkles and limpets. On the Tanganyika coast several varieties of shell fish can be collected and these could be used in the following manner. The fish are plunged into boiling water to coagulate the proteins and cause the shells to open. The flesh is then scraped out and can be fed in mash. It is of high nutritive value and should form not more than 10 per cent of the diet. The shells can be crushed and fed as grit.

Potato peelings.—Potato peelings can form a useful addition to the diet of small flocks of fowls and are best prepared by steaming for an hour in a closed saucepan until they become soft and have a pleasant, appetising odour. They should then be cut up in the pan *whilst still hot* and other constituents of the mash stirred in. Small potatoes can be treated in the same way. The composition of potato peelings varies with their thickness but they can be assumed to contain 20 per cent of dry matter, of which 1.5 per cent is digestible protein. In other words 5 lb. peelings can replace 4 lb. whole potatoes or 1 lb. cereal meal.

Lawn clippings.—Provided only *very young and short* grass clippings are used, they can form up to 30 per cent of the total ration fed to fowls. They are well relished and can be mixed with either dry or wet mashes. It is important that only young short grass is used because grasses in this Territory quickly become too fibrous for poultry. When introducing grass into poultry rations start by adding grass equal to 10 per cent of the cereal fed and slowly increase the proportion of grass until 1 part of grass clippings is mixed with 2 parts of meal mixture.

Sweet potato and cassava tubers.—These tubers can be fed in the same way as potatoes and are probably best prepared by steaming as for potato peelings, though boiled tubers can also be used successfully.

Feeding values of poultry foods

The following table gives a rough idea of the feeding values of the various foods mentioned above together with the figures for the more usual poultry foods. In many cases the figures of feeding values are estimated from analogy with the other foods since no trials have been made with poultry:—

NUTRITIVE VALUES OF POULTRY FOODS (Fresh weight)

	Starch equivalent	Digestible protein	Dry matter
	Per cent	*Per cent*	*Per cent*
Barley (crushed) ..	62	6	85
Buckwheat (crushed) ..	58	7	87
Bulrush millet (ground)	80	10	89
Maize meal	80	8	88
Millet (ground) ..	80	10	88
Oats (ground)	58	7	87
Rice (hulled)	80	8	88
Wheat tailings ..	75	10	88
Cereal mill sweepings ..	70	10	86
Maize bran	60	6	86
Rice bran	50	11	88
Millet bran	70	10	86
Rice polishings ..	80	12	86
Rice dust	70	10	88
Wheat bran (fine) ..	50	10	87
Dried residues from native beer-making..	50	10	85
Sunflower seeds (hulled)	80	12	90
Cowpeas	75	18	87
Beans	70	18	88
Coco-nut cake	65	16	88
Groundnut cake ..	80	38	89
Sesame cake	80	36	88
Potatoes	19	1	24
Sweet potato tubers ..	21	0·6	30
Cassava tubers.. ..	21	0·4	25
Potato peelings ..	16	1·5	20
Meat meal	78	58	89
Boiled meat (condemned carcasses)	24	25	45
Boiled liver	21	17	35
Boiled meat offals ..	18	12	35
Fresh meat offals ..	23	18	30
Shellfish flesh (cooked)	20	18	26
Blood (defibrinated) ..	14	12	16
Ten parts rice dust, seven parts blood, dried together ..	70	15	86
Ten parts maize bran, seven parts blood ..	60	15	87
Yound lawn clippings..	50	8	18
Vegetables (leaves and tops)	6	1	10
Molasses	50	1	75
Separated milk ..	9	4	9
Buttermilk	9	4	10
Whey	6	1	7

THE PRODUCTION AND MAINTENANCE REQUIREMENTS OF POULTRY

The maintenance requirements of British breeds of fowls as given by Halnan (4) are—

	Weight of bird	Digestible protein	Starch equivalent
	Lb.	*Grm.*	*Grm.*
Light breeds	3	5·9	42·0
	4	7·8	50·1
	5	9·8	59·4
Heavy breeds	4½	8·1	50·4
	5½	9·9	59·1
	6½	11·7	64·3

Halnan also gives the requirements for producing a standard two-ounce egg as: 38 grm. starch equivalent 10 grm. digestible protein.

Since many poultry keepers will not want to bother with grammes, it will be more convenient to convert these requirements for maintenance and production into ounces. The easiest way to do this is to consider the maintenance of a flock of 28 birds when the figures in the above table change into ounces instead of grammes, and the requirements for 28 eggs become 38 ounces of starch equivalent and 10 ounces of digestible protein. In all the following computations the rations have been computed on the unit of 28 birds and then if a farmer has, say, 123 birds the amount of food required daily is obtained by multiplying the quantity found for 28 birds by 123/28.

Computation of rations

Armed with these figures of requirements and taking the compositions of the foodstuffs as given above, it is merely a question of arithmetic to obtain a mixture of foodstuffs which will give the required amount of nutrients in 4-4½ ounces of the mixture. In peace-time it is easy to obtain the desired feeding stuffs to make up the correct mixture but under war-time conditions it is not a question of selecting the cheapest or most suitable foods, it is rather a question of juggling with a few foods which are in limited supply and which are not chosen for their suitability but happen to be the only ones available. In order to show how local foods may be utilized a number of rations are worked out below and, by following the procedure used in these examples, it is hoped that poultry keepers will be able to compute better mixtures for themselves from the foodstuffs available to them.

A—Computation of a ration on a farm where separated milk can be given ad lib.

Fowls are very fond of separated milk and can be given this to drink or can have it mixed with their other foods to form a mash. In tests during the dry season at Mpwapwa it was found that very large quantities were consumed, so it is safe to allow for consumption at the rate of 1/10 litre (1/6 pint) per bird per day. If we assume that the ration is for a flock of heavy birds weighing about 5½ lb. each, and laying at the rate of one egg per bird every other day, then—

	Digestive protein	Starch equivalent
	Oz.	*Oz.*
Daily maintenance requirement of twenty-eight birds is	9·9	59·1
Production of half egg daily by twenty-eight birds requires	5·0	19·0
Twenty-eight birds therefore require daily	14·9	78·1
The milk supplied daily will provide	4·0	9·0
Leaving the rest of the ration to supply	10·9	69·1

Birds of this size will consume about 4½ oz. food daily, which means that 28 birds will eat 126 oz. per day. The milk given to the 28 birds will contain 9 oz. of solid matter leaving 117 oz. to be supplied from dry foods. If only cereal-mill sweepings, maize bran and rice dust can be obtained, the final mixture must be arrived at by juggling with the proportions of these foodstuffs until 117 oz. contain 10.9 oz. D.P. and 69.1 oz. S.E. To make the calculations easier it is better to convert these figures to percentages, e.g. 100 oz. of mixture must contain $\frac{10.9 \times 100}{117}$ oz. D.P. and $\frac{69.1 \times 100}{117}$ oz. S.E. which work out at 9.3 oz. D.P. and 59.1 oz. S.E. It will be found that a mixture of two parts sweepings, two parts rice dust and one part maize bran is as near as it is possible to get to the required mixture although even this will contain too much S.E. and will tend to be fattening.

	Digestible protein	Starch equivalent
	Oz.	*Oz.*
40 oz. rice dust supply ..	4·0	28
40 oz. sweepings supply ..	4·0	28
20 oz. maize bran supply ..	1·2	12
100 oz. mixture supply ..	9·2	68

B—The quantity of meat scraps required to balance a ration for a small flock

We will assume that a flock of 11 hens and a cock are kept, that the birds are White Leghorns of about 4½ lb. weight, and that ¼ lb. potato peelings are available daily together

with a mixture composed of 25 per cent coconut cake, 20 per cent maize bran and 55 per cent rice dust or mill sweepings. The feeding-value of 100 oz. mixture is 10.7 oz. D.P. and 72 oz. S.E. and if the birds are to lay 15 eggs each per month the amount of meat scraps to be fed is determined as follows:—

	Dry matter	Digestible protein	Starch equivalent
	Oz.	*Oz.*	*Oz.*
Daily maintenance requirement of twenty-eight birds is ..	—	8·8	54·7
Production of half egg daily by twenty-eight birds requires ..	—	5·0	19·0
Twenty-eight birds therefore require daily	120	13·8	73·7
*Supplied as peelings (9·3 oz. wet weight)..	1·8	0·03	0·3
Leaving other sources to supply	118·2	13·77	73·4
Now 118 oz. of the above mixture will supply..	118·0	12·62	84·9
Which means a deficit of	—	1·15	—

*(4 oz. of peelings are available for 12 birds which is equivalent to $\frac{4 \times 28}{12}$ = 9.3 oz. for 28 birds.)

Boiled meat scraps from the kitchen will contain 25 per cent D.P. and 45 per cent dry matter so that 1 grm. of dry matter in the form of boiled meat scraps will contain $\frac{25 \times 100}{45}$ = 56 per cent D.P. Thus for every oz. of mixture replaced by one oz. of the dry matter in boiled meal scraps the ration will be enriched by 0.56 − 0.11 = 0.45 oz. D.P. The deficit of 1.15 D.P. is therefore made up by supplying daily 1.15/0.45 = 2.6 oz. dry matter in meat scraps or $\frac{2.6 \times 100}{45}$ = 5.8 oz. of boiled meat scraps.

For the flock of 12 birds this works out at $\frac{12 \times 5.8}{28}$ = 2.46 ounces of boiled meat scraps daily.

The owner would therefore feed his fowls the ¼ lb. potato peelings, as much of the mixture as the birds will eat and 2½ ounces of boiled meat scraps daily.

Fresh meat contains more water but less protein than boiled meat and so if meat is purchased specifically for boiling and feeding to the fowls the quantity to be purchased must be about 1¼ times the weight of cooked meat required.

C.—The quantity of meat meal to be used to balance an intensive poultry ration when it is desired to feed 20 per cent of the total ration as molasses.

Birds cannot be put on to a ration containing 20 per cent of molasses straightaway but have to have the molasses introduced in small quantities and the proportions increased slowly until the 20 per cent level is reached. It must be assumed that the birds have been accustomed in this way to eat 20 per cent of their total ration in the form of molasses.

Fowls of this size will eat 4½ oz. daily and a flock of 28 birds will consume 28 × 4½ = 126 oz. dry matter. Every ounce of molasses fed will contain 0.7 oz. of dry matter so that the ration eaten will consist of 4 parts meal mixture and 0.7 parts molasses dry matter, i.e. 4.7 parts = 126 oz. or 1 part = 26.8 oz. The 28 birds will therefore eat 4 × 26.8 or approximately 107 oz. meal mixture plus 0.7 × 26.8 or approximately 19 oz. molasses dry matter = $19 \times \frac{10}{7}$ = 27 oz. fresh molasses.

	Digestible protein	Starch equivalent
	Oz.	*Oz.*
Maintenance requirement of twenty-eight birds is ..	9·9	59·1
Production of 18/30 eggs daily by twenty-eight birds requires	6·0	22·8
Making a total requirement of	15·9	81·9
27 oz. fresh molasses will supply	0·27	13·5
Leaving 107 oz. meal to supply	15·6	68·4
So that 100 oz. meal must supply	14·7	64·5

Calculation will show that 100 oz. of the above mixture of cake, tail wheat and maize bran will contain 13.2 oz. D.P. and 67 oz. S.E., which means that meat meal has to be fed to correct the 14.7 − 13.2 = 1.5 oz. D.P. deficit. Since 1 oz. meat meal contains 0.58 oz. D.P. and the above mixture 0.13 oz., every oz. of mixture replaced by 1 oz. of meat meal will enrich the ration by 0.58 − 0.13 = 0.45 oz. and, to correct the deficit of 1.5 oz., 1.5/0.45 = 3.3 oz. of meal mixture must be replaced by meat meal. Hence the owner will make a meal containing 96½ parts of his cake, wheat and bran mixture and 3½ parts of meat meal and then feed this *ad lib.* to his flock after mixing in molasses at the rate of 1 part molasses to 4 parts of this mixture. It will be necessary to dilute the molasses with water to get a workable mash.

D—The improvement of a ration by means of abattoir blood

Suppose a poultry keeper were feeding a mixture of 1 part groundnut cake, 2 parts cereal-mill sweepings, 5 parts of rice dust and 2 parts of wheat bran to his flock of Rhode Island Reds.

The consumption of 28 birds will be $4\frac{1}{2} \times 28 = 126$ oz. daily. 126 oz. of the above mixture will supply 16.1 oz. D.P. and 84.4 oz. S.E. Daily maintenance requirements of 28 birds is 9.9 oz. D.P. and 59.1 oz. S.E. Which leaves for production purposes 6.2 oz. D.P. and 25.3 oz. S.E.

Calculation will show that the D.P. intake allows for 6.2/10 or 0.62 eggs per day and the S.E. intake will allow for $25.3/38 = 0.67$ eggs per day.

On the face of it this ration would appear capable of maintaining a yield of about 0.6×30 or 18 eggs per month average. Experience has shown, however, [5] that rations containing no animal protein, though supplying an adequate total intake of D.P., do not maintain egg production. Animal protein is essential if such high yields are to be obtained. When meat meal or separated milk is not available blood from the abattoir can be used to improve such a ration considerably. Suppose for example that the blood is defibrinated immediately after it is shed and that it is then mixed with rice dust in the proportions of 7 blood to 10 rice dust and dried for subsequent feeding, and that 10 parts of this blood–rice-dust mixture are substituted for 10 parts of rice dust in the above mixture. This will increase the D.P. available for egg production to 6.8 oz. daily, equivalent to 0.68 eggs a day or equivalent to the yield to be expected from the S.E. surplus. The extra biological value of the amended ration (containing animal protein) will do much to prevent the decline in egg production which would occur with the mixture if no form of animal protein were fed.

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FLAX BY-PRODUCTS AS CATTLE FEED

In view of statements that flax by-products are of value as cattle-feed it is worth while to record authoritative opinions on the possibilities in Kenya. The Director of Veterinary Services writes:—

"The question of feeding flax by-products was first brought to our notice in February, 1942. A sample of 'flax chaff' was forwarded from Sotik for analysis. The result was as follows:—

	Per cent
Water	10.2
Crude protein	13.5
Fat	1.2
Carbohydrate	36.8
Fibre	28.6
Ash	9.7

At the time we reported this as being too high in fibre to be worth while for use except as a roughage."

The Senior Assistant Agricultural Officer (Flax) comments as follows:—

"The majority of flax chaff is produced on plantations during deseeding and consists mainly of crushed seed bolls with a very small percentage of flax seed. The quantity of this material available in Kenya would be 4,000 to 4,500 tons.

There is no doubt cattle readily eat dry flax chaff, but such feeding is not encouraged owing to the high percentage of weed seeds such as dodder, charlock and spurry in the chaff, and a consequent spread of viable seeds in animal excrement. On the contrary planters have been advised to burn the residue or use it as material for compost.

It is doubtful if the feeding value would justify cooking to render weed seeds non-viable.

A further source of chaff and light flax seeds is the residue from the seed-dressing centres; this, however, will be utilized by the oil mill at Molo (under the supervision of the Flax Board), for inclusion with surplus seed for the production of linseed cake."

AGRICULTURAL EDUCATION IN NYASALAND: MAKWAPALA TRAINING CENTRE

By H. V. Newby, B.Sc. Agric., B.Sc. Bot. (Lond.), Agricultural Officer in Charge

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The Agricultural Training Centre at Makwapala, near Zomba, was started in October, 1940, with the object of providing a staff of trained native agricultural instructors for service in the Nyasaland Department of Agriculture. The lack of such trained Africans had long been felt by the District Agricultural Officers and plans for a training scheme had been under consideration for some time before the Centre was finally opened. The site is the old Makwapala Experimental Station, and in 1939 a central building of two large lecture rooms was constructed, while the existing station buildings were modified to meet the needs of the new training institution. Makwapala lies close to the south-west corner of Lake Chilwa at an altitude of approximately 2,300 feet. The total area of the Station is 100 acres, but only 65 acres are under the plough. The soil is a very poor, sandy loam, for the most part extremely shallow and overlying a lateritic subsoil. A narrow strip of fertile, black alluvium, along the Matawale stream, is used for tobacco nurseries, rice plots, and a vegetable garden.

The Centre is planned to take forty students and the training occupies two years, thus extending over two complete cycles of agricultural operations. It is staffed by the Agricultural Officer in charge; one African Assistant Teacher, who is a native Civil Servant in Grade II and holds the English Grade teacher's certificate; and latterly, two African Field Demonstrators who have recently completed their training at Makwapala. The minimum qualification for entrance was originally fixed at Standard 4, with consideration for Standard 3 in special cases; but this minimum has recently been raised to Standard 5, with preference to candidates having Standard 6. The candidates are mostly between the ages of 18 and 25 years, some coming direct from Mission schools, others having had some previous employment such as village school teachers, assistant storekeepers, and assistant capitaos. During the third session (1942-43) however, the year's batch of entrants was drawn from the existing staff of partly trained native Agricultural Instructors. Until the commencement of the training scheme at Makwapala, the native Agricultural Instructors were recruited from men of good character, but as often as not of scanty education, who were employed to perform certain routine district duties under the supervision of the Agricultural Officers or their Assistants. Such knowledge of agriculture as these men came to possess, they usually picked up piece-meal from the specific instructions given to them for any particular work in hand. Although many of them did good work, their usefulness was clearly limited by the lack of any sound background of technical knowledge. The men who were chosen from the ranks of this partly trained staff, to be seconded to Makwapala in 1942 for the full two years' course, all had several years of good work to their credit; and further, only men who had attained to Standard 3 in their school education were considered in making this choice. Those who qualify at the end of their course will return to their duties under the new and much improved conditions of service which have been instituted for Africans who have been trained at Makwapala.

Upon passing the final examination at the end of the two years' course, a student enters the native Civil Service, Grade III, as a trained native Agricultural Instructor. Every applicant who is admitted to the course signs an agreement in which he undertakes to enter this work upon the successful completion of his training. After qualifying at Makwapala, the trainee then serves upon probation for a period of three years before being confirmed in his appointment. During his training at Makwapala the student pays no fee, but is given a small monthly cash allowance and is provided with food for himself and his wife. Every married student is encouraged to bring his wife to live at Makwapala for the duration of the course. The women receive instruction in handicrafts, especially in spinning, knitting and weaving cotton yarn, under the direction of the wife of the Agricultural Officer. Their enthusiasm for this work is very striking and they produce numerous well-made garments for their families, using the cotton which the students themselves have grown.

Candidates for Makwapala go through a fairly rigorous process of selection. Those who satisfy the Senior Agricultural Officer of their Province in regard to their educational qualifications and general school record are, whenever possible, given a preliminary interview. The candidates are then required to enter, in the first place, for a short probationary course, which is held at Makwapala at the beginning

of each annual session, and which occupies approximately twelve weeks. During this period they take part in all the work which is in progress upon the farm and receive lessons which aim at refreshing certain of their school subjects, particularly arithmetic, and which include an introductory course entitled General Agriculture. This course introduces, in a very brief and elementary way, the more important principles of good agricultural practice, sets out some of the major agricultural problems and needs of the Protectorate, and generally indicates what standard of work will be expected of the students if they qualify for the post of native Agricultural Instructor. Particular attention is paid to the attitude shown by probationers towards taking part in daily manual work upon the farm, and no candidate is admitted to the two-year course who does not prove himself to be a willing and efficient worker in this respect. This has been found to be a very valuable yardstick in estimating the suitability of candidates for the post in view; and it is impressed upon every student, during his training, that a successful Agricultural Instructor is one who is prepared to take off his jacket and demonstrate to villagers the best way to begin digging a storm-drain or make a contour bund. Any student who feels that it would be beneath his dignity to give such practical demonstrations is advised to look for other employment.

In the fifth week of the probationary course a series of tests is begun. These occupy one or two days every week for the remainder of the period and are designed to test the following points: (*a*) ability to report clearly upon simple district duties undertaken in neighbouring villages; (*b*) degree of interest taken in local agricultural practices prior to coming to Makwapala; (*c*) capacity to learn by intelligent performance in, and observation of, field work in progress on the Makwapala farm; (*d*) learning capacity in lectures; (*e*) ability to give clear, brief answers to simple questions; (*f*) general ability in elementary arithmetic. The performance of each probationer in these tests is considered together with his record for field work over the period, and his general bearing and conduct; and upon the general summing-up of these aspects his admission to the full course of training depends. It is probable that selection tends to err upon the side of severity, but that tendency is undoubtedly to the ultimate advantage of the work of the Department.

The activities of the Centre may be conveniently described under three headings; (*a*) instruction, practical and theoretical; (*b*) the community life of the Makwapala Village; (*c*) extension work in the neighbouring districts.

(*a*) *Instruction.*—The daily time-table allows for three to four hours of practical work upon the farm, divided into two periods—early morning and late afternoon; two hours for lectures in the classroom; and one hour for individual study. This curriculum has worked well and seems to preserve a fair balance between practice and theory. No attempt is made to run the Makwapala farm entirely by student labour. Although each student makes first-hand acquaintance with every kind of work upon the farm, he is not allowed to become stale in any one piece of work. The students are directed mainly to such practical work as will help to exercise and impress the teaching which they have been given. Two Field Instructors are on duty to supervise the practical work, to discuss the methods with the students, and in general to ensure that there is an atmosphere of instruction about all the field work in progress. It has always been found that in this way students work well, it never becomes necessary to set tasks (that would be a disgrace, merited only by offenders undergoing punishment), and many heated but amusing discussions upon technical points may be heard in progress among the groups of students at field work.

The practical work includes the cultural operations for all the principal food and economic crops throughout their cycles; the general management of cattle and sheep, with special attention to acquiring skill in milking and simple dairying; anti-erosion methods; compost making and green manuring; building of grain stores; the use of ox-drawn implements; land measurement and levelling. A large vegetable garden is maintained entirely by the students and furnishes an ample supply for their diet. All groundnuts required for feeding are also produced on the Centre, but only a fraction of the maize and pulses needed. The growing of crops solely for food is strictly subordinated to the need of growing representative areas of as many different crops as will thrive at Makwapala, for the purpose of instruction; and this factor, together with the comparatively small arable acreage upon the Station and the need of keeping a considerable proportion of the very poor soil under green manure crops (chiefly sunn hemp), leaves the Centre very far from being self-supporting in foodstuffs. The following crops are regularly grown, in areas ranging from one quarter of an acre to six acres, with various arrangements of inter-planting where feasible; maize, sorghums, bulrush and finger millets, rice (swamp and hill varieties), dark-leaf tobacco, cotton, legumes of many kinds, citrus and other fruits, sugar cane, sweet potatoes.

The following summarizes the syllabus of lectures, and it will be seen that crop husbandry and related subjects form the main theme in the first year, while animal husbandry has an important place in the second year.

Syllabus:—

(1) *First Year.*—The major subjects in the first year are: soils, crops, plant life, insect life, mensuration, levelling.

In addition to these, the following are taught as subsidiary subjects: arithmetic, elementary book-keeping, citizenship, English.

(2) *Second Year.*—The major subjects are: live stock, animal physiology, crops (advanced course), agricultural geography of Nyasaland, mapping.

In addition there are short subsidiary courses on: English, report writing, hygiene.

There are no lecture courses upon any branch of pure science as such. All teaching in the major subjects is strictly related to agriculture, and scientific principles and concepts are introduced into these lessons at appropriate points. After much deliberation this plan was adopted for two main reasons: it avoids any temptation to spend too much time out of the short space of two years upon purely theoretical aspects of science; and it prevents the student from keeping science and agriculture in water-tight compartments in his mind, but ensures that he shall understand the application of every scientific fact which is presented to him. During their second year students deliver short lectures and lead discussions upon selected topics.

(*b*) The Makwapala Village is the focus of community life at the Centre. The building of this village is largely an achievement of the students themselves; for the original plan of housing students in dormitories was abandoned soon after the opening of the Centre—in fact, just as soon as the Agricultural Officer, with the aid of the first batch of students, was able to construct a sufficient number of two-roomed pisé-de-terre houses to form the nucleus of the village. There is now a comfortable house for every student; and since the majority of students are married and are glad to bring their wives and younger children to live at Makwapala, a real community has grown up, opening the way for community training. A Students' Committee of six ordinary members, and presided over by a School Chief, looks after the well-being of the inmates of the village, being responsible for such matters as the cleanliness of the houses and their surroundings; the distribution of foodstuffs to the families; the health of the community—making sure that the first signs of sickness are immediately reported to the Dispensary; discipline—with powers to hear and settle any minor disputes, assigning penalties if necessary; and the organizing of football matches, concerts and other social gatherings. The supervision of certain of the School Rules is delegated to the Chief and his Committee, and this body has proved to be of much assistance to the Agricultural Officer in charge. Every student serves one or more terms of office upon the Committee, the members remaining in office for one month only, but being eligible for re-election at a later date. The School Chief is elected by the students from nominations made by the Agricultural Officer; these nominations are usually confined to students who are in their second year. The School Chief holds office for two months, so that, of the students in each second-year group, nearly one-third hold, in turn, this coveted place. The training which every student receives in this Committee system engenders a sense of responsibility towards the community in which he lives; it is confidently hoped that this civic sense will remain much in evidence in his activities after he has left the Centre and been drafted to his sphere of duty.

(*c*) Extension work provides one other valuable aspect of the training at Makwapala. Each student is made responsible for a village area in his second year, where he carries out a programme of agricultural instruction and generally acts as a liaison member between the Agricultural Officer of the Centre and the principal village headman. The student thus gains first-hand experience of the kind of work which will be his main occupation after qualifying. Considerations of time and distance limit his activities in this respect to intensive rather than extensive district work during his studentship. The neighbouring districts lack no opportunity of learning better methods of agriculture; and the general results obtained over a period of four years speak for the persuasiveness and the assurance with which young Africans who have put their hearts into learning agriculture can impart their knowledge.

The Training Centre is still in its infancy. Started in the darkest year of the War, it was an early, but fundamental step in a long-term policy for better native agriculture in Nyasaland. Two batches of qualified trainees are now in the field, and the third batch will shortly complete their course. The output of trained instructors will not, however, satisfy the demand for a very long time to come. Meanwhile the better times which now seem to be approaching call for an expansion of the work of the Centre, and plans are already under consideration for its removal to a larger and better site.

A NEW BACTERIAL DISEASE OF THE POTATO IN KENYA

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C., Senior Plant Pathologist, Kenya

The object of this note is to draw attention to a bacterial disease of the potato (*Solanum tuberosum*) which has recently appeared in Kenya.

Another bacterial disease caused by *Bacterium solanacearum* and known as the "Brown Rot", is already well known in Kenya. A brief mention of its symptoms will serve to distinguish it from the new disease. The "Brown Rót" attacks both haulms and tubers and like the new disease, also causes a wilt of the plant. Affected plants have the woody strands of the stem discoloured as is seen when they are cut across. The stems themselves may be brown or blackened, usually at first on one side. This is followed by a blackening and collapse of the whole plant. Tubers are also infected and quickly develop a rot, but if they are cut across while still firm, the ring of vascular tissue is seen to be discoloured brown with an exudation of slimy bacterial masses. These bacteria may also ooze from the eyes and heel end of the tuber and, on drying, cause particles of earth to stick to the surface.

B. solanacearum attacks many plants and is frequently the cause of a wilt disease of tomatoes, egg plants, tobacco, and other cultivated members of the potato family. It is typically a disease of the warmer parts of the Colony.

The symptoms of the new disease appear to be identical with those of the "Ring Rot" caused by a species of bacterium known as *Corynebacterium sepedonicum.** This is a disease which, up to the present, has been recorded only from Central Europe and the North American Continent. About ten years ago Ring Rot was unknown in America; it is now, however, one of the major diseases of the potato in the Northern States and Canada. It is proposed, for the time being, to refer to the disease in Kenya as the "Ring Rot.

An early indication of the disease is a wilting of the leaves. These droop and tend to have the margins of the leaflets rolled inwards. At first, individual leaves only may be affected while others remain turgid. Not infrequently one stem only of a plant may be affected. Eventually, however, the whole plant wilts and turns yellow. Later, especially where the soil is wet continuously, other organisms cause a wet rot of the stems a few inches above soil level and the plant collapses. There is no blackening of the stem or leaves as may occur with the "Brown Rot". If the stem of an affected plant is cut across, white bacterial masses can be squeezed from the ends of the vessels but there is no marked brown ring. The figures 1 and 2 show successive stages of the progress of the wilt. This plant was infected by pricking the stem with a needle, contaminated with the bacteria, two or three inches above soil level. It will be seen that the disease has not yet reached the second stem which is part of the same plant.

A striking and dangerous feature of this disease is that it cannot always readily be detected in the tuber without cutting the tuber across. The tubers from a wilted plant, all of which may be infected, may appear externally to be quite healthy, firm and of a normal colour. When such tubers are cut across, however, the vascular ring, which in a healthy tuber is only faintly discernible, is a yellow or cream colour. On being squeezed, whitish putty-like masses of bacteria can be made to exude. In slightly more advanced stages, the masses of bacteria can be seen embedded in the tissue, although there is still no external sign of the disease. The bacteria can also be demonstrated by leaving the cut tuber in a moist atmosphere when wet shining beads of bacteria will exude from the ring (Fig. 3). Eventually the eyes become affected and turn black. Other organisms gain entry and produce a secondary rot of the tuber. This may happen in the ground or in storage. Diagnosis of the disease at this stage is difficult or impossible. These symptoms agree with those of the Ring Rot given in a recent publication by L. C. Knorr ("Ring Rot of Potatoes". *Cornell Exp. Station Extension Bulletin*, No. 620, 1943).

Ring Rot is a highly infectious disease which can be transmitted to healthy tubers by cutting with an infected knife and also by contaminated bags, tools, machines, packing sheds, etc. Figure 4 shows the effect of planting an infected seed piece. This plant was derived from a tuber, the cut surface of which was smeared

* As all attempts to demonstrate a gram-positive organism have so far failed, the identity of the pathogen must for the time being, remain in doubt.

FIG. 1

Left. Stem of potato plant inoculated by pricking with a needle contaminated with the bacteria. Two of the leaves have wilted 13 days after inoculation

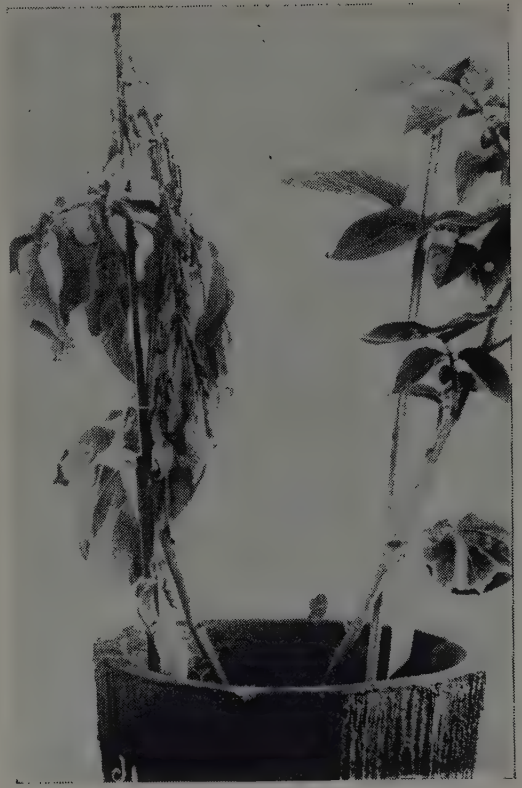

FIG. 2

The same plant as Fig. 1, 16 days after inoculation. The bacteria have not yet reached the stem on the right which is part of the same plant.

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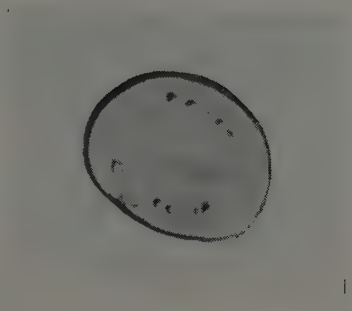

FIG. 3
Young tuber from an inoculated plant, showing the exudation of bacterial masses.

FIG. 4
Plant from a seed piece, the cut surface of which was smeared with the bacteria just before planting. Photograph taken 29 days after planting and showing the characteristic wilting and curling of the leaflets.

with the bacteria from an infected tuber. The photograph was taken twenty-nine days after planting and shows the characteristic wilting and curling of the leaves. The chief danger lies in the fact that tubers which appear externally to be healthy, may be planted and give rise to diseased plants or misses. It is not apparently carried over from season to season in the soil but in Kenya where volunteer plants are so persistent it will not be easy to eradicate. The control measures at present recommended, should the disease appear, are to use for seed none of the stock in which a case of Ring Rot has been detected, and to pay vigorous attention to the disinfection of all material used in the handling of the crop. Fresh seed should be obtained from a disease-free source. Cutting of the seed from a slightly infected crop may lead to a big increase of the disease in the subsequent crop. It is stated by Knorr (1943) that in one season the disease may increase from a trace to 60 per cent.

ADDENDUM

Since going to Press, a culture of *Corynebacterium sepedonicum* has been received through the kindness of Dr. L. C. Knorr. Although it has not yet been possible to make a detailed comparison, it seems that the organism causing the Kenya Ring Rot disease cannot be identified with *Corynebacterium sepedonicum.*

THE VALUE OF FUNDAMENTAL RESEARCH

Naturally applied science must be stressed in all agricultural research carried on by public agencies. But the development of basic information and the discovery of principles upon which practice can be based make it possible to arrive at a more speedy, direct and satisfactory solution of problems. The whole progress of science and the application of its findings depends on filling in the gaps in our knowledge of the nature of things. There is a very definite limitation indeed to the extent of progress which can be made without a backlog of fundamental knowledge.

Hybrid corn, planted on approximately 50,000,000 acres this year, is a familiar example. We all know that the development of hybrid corn was preceded by a good deal of work which most people would consider purely theoretical genetics. Perhaps not all of it was essential to the practical breeding operations, but a good deal of it was. Waxy corn was a by-product of some of this work; it had no practical value at the time it was discovered but was carried along for its theoretical interest. Now it is of very great importance, along with waxy sorghum, as a source of a possible substitute for tapioca starch.

The work on the influence of day length on plant development and distribution is another case in point. Among many other things, an understanding of the photoperiodic requirements of different plants has affected agricultural production in widely different ways. It has made it possible, for example, to produce potato seed for breeding purposes under controlled conditions in large quantities, to determine the adaptability of many kinds of plants to widely separate areas and eliminate the practice of trying to grow them in regions to which they were not suited, and to control the blooming time of chrysanthemums and other florists' crops; and it has helped to make it possible for us to become independent of foreign sources of sugar-beet seed.

Another example is the seemingly abstract research on the effects of plant hormones on the physiological and anatomical responses of plants. This work has been applied to the prevention of early dropping of fruits, facilitating the rooting of plants for propagation and transplanting, wound healing, maintaining the dormancy of nursery stock, fruits and vegetables in storage, greatly increasing the percentage of fruit set on crops such as tomatoes, and increasing the size of some fruits. There have been many other applications, and a whole new chapter in man's control of plant development through chemical means is in the making.

An especially striking example of the importance of supporting fundamental research is found in the remarkable results now being obtained with penicillin in preventing or clearing up infections. All the funds that have been provided for many years to study the growth, reproduction, physiology, relationships and life histories of the many species of plants grouped under the general term "fungus" would be justified by this one discovery, even if all such work had not already been paid for very many times over by economic applications of the results of critical research. Because of the knowledge of investigators versed in the cultivation of fungi on a large scale, it will now be possible to produce large quantities of penicillin and save the lives of thousands of people.

DR. F. C. AUCHTER in *Science* 99 : 173, 1944.

THE HISTORY OF A HERD at the Coffee Research Station, Lyamungu, Moshi, 1935-1944

By S. M. Gilbert, Chief Scientific Officer

(*Received for publication on 15th July*, 1944)

Introduction

When considering the long-term programme of work for the Coffee Research Station at its inception in 1934, upkeep and improvement of soil fertility naturally called for inclusion in the investigations to be undertaken. Was organic matter one of the best ways of maintaining fertility and was the manufacture of cattle manure and compost practicable? In view of work on sugar cane [1] in Trinidad and on tea [2] in India which showed that inorganic nitrogen in the form of sulphate of ammonia was more efficient than organic manure the question was important. It may be said in passing that no results* so far achieved at this station prove that the application of compost (farmyard manure has not been applied by itself) is economical compared with artificials.

However to make compost in quantity for experiments and for nursery work farmyard manure was needed and therefore cows were purchased solely to provide manure. This article describes the history of this herd during ten years and describes the change in outlook in regard to animal husbandry as an adjunct to coffee production over that period. No special merit attaches to the performances recorded. They are statements of records of an ordinary, native herd kept with a reasonably high standard of animal husbandry and as such may be of interest to planters contemplating keeping stock.

Development Since 1935 in Animal Husbandry

At this time the station was being laid out with an eye to future requirements mainly in regard to areas for coffee experiments. Many areas were clearly unsuitable for this purpose but could be productive of such useful things as coppice (for firewood), bananas and fodder grasses (for mulches and cattle food), and pastures.

It was pointed out about this time that the station could serve a useful function by providing native bulls of known pedigree for improving local stock. In addition to providing manure, therefore, the herd was to be improved for producing bulls of good type. This necessitated a higher standard of animal husbandry. Improvements have been carried out progressively and will continue as conditions permit.

Foundation Stock

Eight cows were purchased in 1935. Four were from a European-owned herd and almost certainly had slight Ayrshire blood in them. The other four were native stock from Mbulu and of a smaller type than the first four. One of each lot succumbed to east coast fever in the first year. A local native bull was also purchased. The average price of the cows was Sh. 35.

As a result of good housing and of feeding based on scientific rations the herd gradually improved in appearance and cows calved annually as against the erratic calving, often only once in three years, of neighbouring cattle kept by natives. Recording of milk yields was commenced in 1936 and has been maintained up to this date.

The first attempt at grading-up was by using a son of Rifo which at that time appeared to be the best foundation cow. In November, 1937, a bull, Congo, was purchased from a European planter. Its record was unknown but it came of a herd with a good reputation.

In the meantime the milk records were accumulating and showing a big variation in performance of the foundation cows.

When heifers sired by Congo became ready for service they compared very favourably in appearance with their mothers (*see* tables) and it was decided in view of the great influence of the bull to take another definite step forward in "grading-up" by the purchase of a native pedigree bull. With the kind co-operation of the Director of Veterinary Services, Kenya, a good type Baraton bull was sold to us. His history is given below:—

BULL No. 86

Bull No. 86	.. ..	.. C.R.S.I.
Born	.. ..	.. 13th August, 1938
Colour	.. ..	.. Black
Arrived	.. ..	.. 11th January, 1941
To Herd	.. ..	.. 6th March, 1941
No. 86	Sire 16	Sire not known.
		Dam No. 11
	Dam 81	Sire not known.
		Dam No. 41

* The manufacture of compost and its effects on coffee will be the subject of another article in due course.

Dam	Milk in lb.	Days	Butterfat	Lactation
	Lb.		*Per cent*	
No. 81 ..	2,342	255	5·5	First
	3,082	268	5·4	Second
	2,890	291	5·7	Third
	2,706	291	6·0	Fourth
	3,637	322	5·9	Fifth
No. 41 ..	1,776	309	6·6	First
	1,275	247	6·3	Second
	2·031	319	6·2	Third
	2,783	311	5·8	Fourth
No. 11 ..	2,080	215	5·7	First
	1,516	155	6·5	Second
	2·117	203	6·0	Third
	2,278	202	5·76	Fourth
	1,298	110	5·46	Fifth
	1·370	142	5·0	Sixth

The first heifer calves by this sire will be ready for service in 1945 and it will be necessary to have a new and unrelated bull by that date for use with these heifers.

The following family trees give in detail performances to date.

FAMILY No. I

No. 2—RIFO*–(?)–5–1,778 lb.

- Naivasha 4/40 (Died as calf)
- Victoria 10/42 (CRS I)

Rifo has given good-type bulls which were used on the herd before Congo and CRS I were available.

FAMILY No. II

No. 4–KURBHAI*–(?)–7–1,390 lb.

- Buruma 4/36–6–1,943 lb. (Unknown bull)
  - Nduruma (1) 8/40–1–1,630 lb. (Lupa)
    - Rukwa 4/43 (Wrong bull in error)
- Kilimanjaro 10/37 (Died of "fly")
- Weru-Weru (2) 9/40 (Lupa)
  - Mwaya 12/43 (CRS I)
- Nyasa 9/42 (CRS I)

FAMILY No. III

No. 3–NDULU*–(?)–7–892 lb.

- Monduli 9/36 (Scrub bull) (Culled) (No heifer calves)
- Kampala 11/37–3–1,173 lb. (Scrub bull)
  - Jinja 8/43 (CRS I)
- Mbeya 10/38 (Drowned) (No calves)
- Arusha 9/39–2–2,140 lb. (Congo) (To date no heifer calf)
- Tanga (3) 8/41 (Mbuni)
  - Kilwa 3/44 (CRS I)
- Mwanza 10/42 (CRS I)

FAMILY No. V

No. 5–MBULU*

- Rasha-Rasha 5/38–3–1,730 lb. (Scrub bull) (All bull calves)
- Ngare-Nanyuki† 3/39–2–1,430 lb. (Congo)
  - Cheya 1/43 (CRS I)

FAMILY No. VI

No. 6–IMANI–(?)–6–795 lb.

- Sitimu (4) 4/39–1–484 lb. (Congo)
  - Dodoma 6/42 (CRS I)
  - Mwera 8/43 (CRS I)
- Mamba 9/42 (CRS I)
- Mtenga 4/43 (CRS I)

FAMILY No. VIII

No. 8–Angwasi*–(?)–6–992 lb.

Bulugu* 1/36–6–1,113 lb. (Scrub bull) | Tengeru 11/37–3–1,409 lb. (Mbuni) | Kaya (6) 11/38–2–2,293 lb. (Congo) | Chunyu 10/42 (CRS I)

(Only heifer calf died) | Naruma 1/43

Rudiani (5) 7/39–1–1,141 lb. (Congo) | Tabora (7) 7/41 (Mbuni) | Pemba 7/43 (CRS I)

Magamba 2/43 (CRS I)

NOTES

(*a*) The figures after the name of the cow refer to: (i) Date of birth ; (ii) Number of lactations ; (iii) Average milk yield in pounds. All cows are dried off at 300 days if not already dry. Thus the averages apply to both annual and lactation yields.

(*b*) The name in brackets under that of the progeny refers to that animal's sire.

(*c*) Cows numbers 2, 3 and 4 had a trace of Ayrshire blood, numbers 5, 6 and 8 were pure native.

*Calf also suckled mother.

†Teat trouble.

(1) Yield in second lactation to date (21st May, 1944) 866 lb. in 47 days.
(2) Yield in first lactation to date (21st May, 1944) 1,073 lb. in 161 days.
(3) Yield to date (21st May, 1944) in first lactation, 495 lb. in 55 days.
(4) Yield to date (21st May, 1944) in second lactation, 2,989 lb. in 284 days.
(5) In second lactation has given 2,036 lb. in 155 days.
(6) In third lactation has given 2,331 lb. in 142 days.
(7) On first lactation has given 738 lb. in 124 days.

Miscellaneous

(*a*) *Housing.*—The original building was a concrete shed, with corrugated iron roof, divided into three parts, one open, for housing and manure making.

To-day the buildings consist of a cow-shed with proper stalls and swinging stanchions for sixteen cows together with the necessary feeding and cleaning passages; calving pens; screened milk room; separate calf house with twenty stalls and two portable bull pens. These have all been adapted or built and equipped by improvization by the station staff itself. A clean running-water supply has been laid on.

(*b*) *Pastures.*—Tick-borne diseases such as east coast fever were common in 1935. It was therefore decided to fence the entire station and to lay out proper fenced paddocks for grazing. No new stock has been introduced except stud bulls. The latter have been carefully quarantined. As a result of this policy there has been no case of east coast fever since 1936. The paddocks, which are grazed on a rotation, are on average from one to one and a half acres each and the total area of fenced grazing is thirty acres. Most of the area is under the indigenous *Pennisetum salifex* in the bottom lands with *P. clandestinum* on the medium slopes and *Cynodon dactylon* on the hill tops; the last two have been planted.

(*c*) *Bananas and Fodder Grasses.*—These were primarily planted for providing mulch for the coffee and bulk material for compost making. In practice they also provide green food and bedding for the cattle. They cover about fifty acres and are being extended. The cutting of the fodder grasses which are mainly *Pennisetum purpureum* (Elephant Grass) and *Panicum maximum* (Guinea Grass)—two types—must be timed for the particular purpose for which the grass is required, that for fodder being cut in a young stage, that for compost in an intermediate and that for mulch in the full-grown stage. Elephant Grass, cut at four-monthly intervals, yields some fifty tons to the acre. Guinea Grass yields at less than half of this rate.

(*d*) *Milking.*—Within the limited means available a high standard of hygiene is attempted. This cannot however be satisfactory until proper buildings and sterilizing equipment are provided.

In the meantime through the kind assistance of the Kenya Veterinary Department four men were trained for us at Ngong as milkers. Lack of supervision is immediately reflected by a drop in milk yields due to carelessness in not milking cows dry.

Cows are milked three times a day until the mid-day yield drops to 2 lb. when only morning and evening milking is done.

It was not found possible to milk any of the original cows without partial suckling by the calf. With one exception (Buluga) this has been achieved with heifers born on the station. With these the calf is taken away immediately at birth.

(*e*) *Feeding.*—In general the herd grazes during daylight and is housed at night. Elephant grass is fed in the stalls at a rate of about fifty pounds per head. Salt lick is available.

In addition a mixture is given of maize meal, sim-sim or groundnut cake, bran, molasses and cotton seed as available and according to price. The amount is based on the recognized standards of starch equivalent and protein required for maintenance and production of milk per estimated weight per animal.

Natural Increase and Factors Affecting it

Since the original purchase of eight cows in 1935 ninety-two calves have been born. Of these forty-two or 45 per cent have been heifers. Of the ninety-two born, two died very young at a time when their mothers had bad attacks of trypanosomiasis; two died by avoidable accident and seven from causes unknown but probably pneumonia due to lack of simple protection against chills after birth. In other words, under conditions obtaining at this station, calf mortality should be negligible. Twenty-five animals have been sold for stud purposes or to the butcher. Twelve adult animals have died. Of these two died of east coast fever shortly after their arrival, one died of an unknown cause and ten died of "fly"—six of them in 1940. Mortality from this cause seems to be low in well-fed cows and high in oxen on grazing only, without concentrates.

Trypanosomiasis.—Two species of "fly", *Glossina pallidipes* and *G. brevipalpis,* have been caught on the station. During the past ten years the "fly" has rarely been seen, but in some years, particularly 1940, the cattle were badly attacked. Deaths occurred and milk yields were seriously affected. These outbreaks have been confined so far to the period December-March, that is, between the end of the "short rains" and the beginning of the "long rains". This period is usually hot and dry. The wind is from the north-west and it is possible that the "fly" is in fact seasonal being blown over from the gorge of the Weru Weru River about one mile to the west of the boundary. It is known that the "fly" travels up the river gorges on Kilimanjaro at this season. It is endemic in a belt of country from five to six miles away and about 1,000 feet below the station.

General measures taken against the "fly" are (i) the regular cutting of thicket on uncultivated land on the station and (ii) the sharp definition of the boundaries of forest areas.

Special control is effected by weekly or fortnightly blood tests during the critical period and by injections of Stibophen when an animal contracts the disease.

The Future

The Wachagga are keenly interested in the herd and there is a brisk demand for bulls both from them and from planters. When peacetime conditions return it is hoped to quicken the process of grading and the introduction of a good pedigree Sahiwal bull from India may be tried.

REFERENCES

[1] P. E. Turner, 1934.—*Emp. J. Exper. Agric.* 2, 78-92.
[2] P. H. Carpenter, 1938.—*Emp. J. Exper. Agric.* 6, 1-10.

STYLE

Manner of speaking or writing is often an indication of a person's mental make-up, and, as a modern writer has asserted, faults of style may reflect faults of character. At any rate in the world of to-day, ability to express oneself well in speech and script is a most useful quality; and it is a quality that can be taught to, and learnt by, most people, if they take the necessary pains. The trouble with most poor writers is that they are lazy: they lack the "passion to excel" of the artist and the craftsman. The technical writer, in particular, is often so keen to communicate his knowledge, to "get there", that he does not worry about style or method of presentation, and therefore, is put down as an unlettered man; whereas by taking thought and a little trouble, he could greatly improve his style and "put it over" far more satisfactorily.

Of the factors that make for good prose composition, perhaps the chief is having something to say; but that is run very close by being able to say it clearly, precisely and concisely. Clarity is fundamental, and it is achieved not only by thinking clearly, but also by knowing the exact meanings of words, by ability to choose the *mot juste,* and by the more technical procedure of arranging words, sentences and paragraphs in logical order. "Style is connexion", said Jowett, "art is putting things in their places". Balance and rhythm are also valuable qualities.

Dr. E. H. Tripp in *Nature.*

DERRIS AGRONOMY: AN ANNOTATED BIBLIOGRAPHY AND A CRITICAL REVIEW

PART II

By R. E. Moreau, East African Agricultural Research Institute, Amani

Shade

Ishigai (1937 *cit.* Sievers, 1940) has made the statement, presumably on the basis of experience with *D. elliptica* in Formosa, that "partial shade is preferable to too much sun". This must be read in conjunction with the view of Cahn (1935) that "given high humidity" derris (type not specified) "tolerates any amount of direct sunlight".

Since, as a rule, derris is grown where humidity is high it is not surprising to find a consensus of opinion that shade is bad. In Ceylon (Report for 1933), derris did very badly indeed when interplanted in old rubber, but quite well between young rubber, an effect probably due in part to shade. Huitema (1938) has stated that "shade is never beneficial for the growth and root-formation of derris as has been shown by experience under cassava, *Leucaena* and *Albizzia*". He cites an experiment in which derris planted under three-year-old rubber increased only 21 per cent in root weight between its 18th and its 30th month, "doubtless owing to the root competition of the *Hevea* and suppression by too much shade". He adds, "for the best development plants need to be in the full sun, which does not alter the fact that derris can be very profitable as a catch crop planted simultaneously with *Hevea*". (A large proportion of the commercial Malayan derris was interplanted.) Moore (1943) is emphatic on the dependence of root-yield on exposure of leaves to sunlight in Puerto Rico.

There is no indication that any experimental work has been done on the photosynthetic relations of any species or type of derris, nor that the relationship between humidity and light-tolerance has been investigated. The effects of staking (supporting) plants of a normally prostrate type have received some consideration from this point of view in Puerto Rico (Moore, 1943).

The Age for Harvesting

The age at which it is economically the best to harvest derris root is determined partly by changes in the toxic content and partly by the growth increment of the root. The nature of the growth introduces a third factor when the increment is partly made up of undesirable coarse root (*see* section 7).

The ages recommended for the harvesting of various types and in various countries are shown in Table 4. It will be seen that the age for harvesting the Amani clone of *D. elliptica* differs by being about half as long again as any others. This is due to a combination of three factors:—

(1) The maximum rotenone percentage is achieved later.

(2) The rotenone percentage does not diminish thereafter.

(3) The root as a whole appears to continue its gain in weight without producing a kind of root low in rotenone.

It is not known to what extent soil, climatic and inherent factors contribute to these results.

The weight increment in the later stages may be very rapid. For example, Huitema (1938) gives as the preliminary results of replicated trials with clonal material, $3\frac{1}{4} \times 6\frac{1}{2}$ feet, yields of 230, 410 and 950 lb. of air-dry root per acre at $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ years respectively. Unfortunately he does not state whether any of the increment has to be rejected as too "coarse" and low in toxic content. This rapid increase apparently only takes place, however, in derris not so interplanted as to suffer from competition.

Root Character and Toxicity

The following generalization has been made in the Mayaguez (Puerto Rico) report for 1939: "Chemical analyses reported for rotenone-bearing plants have uniformly shown that, for any one clone, the fine rootlets contain relatively little rotenone, small roots (from 2 to 5 mm. in diameter [1/12 to 1/5 inch]) are generally highest in rotenone, and the percentage of rotenone diminishes progressively as small roots thicken." Important exceptions to this generalization have, however, been reported, notably for the Amani clone of *D. elliptica* (*see* below).

TABLE 4

RECOMMENDED AGE FOR HARVESTING (in months)

Country	Type	For Highest			On all counts	Reference
		Rotenone	Ether extract	Yield by weight		
Philippines ..	Presumably *D. elliptica*	—	—	—	21–23	Adriano *et al.*, 1934.
,, ..	*D. elliptica* D9 ..	24	—	—	—	Silayan, 1940a.
Malaya	*D. elliptica* Sarawak Erect	—	21*	—	21	Malaya Rept. for 1938.
,, ...	*D. elliptica* Sarawak Creeping	—	—	24	—	Malaya Rept. for 1939.
,, ...	*D. malaccensis* var. *saraw.*	—	—	24†	—	Malaya Rept. for 1939.
,, ...	,, ,, ,,	—	—	—	23	Greenstreet, 1930.
,, ...	*D. elliptica*	—	—	—	18–22	Anon., 1934.
,, ...	,, ...	—	—	—	23	Greenstreet, 1930.
,, ...	,, Sarawak Creeping	—	—	—	18–22	Anon., 1934.
,, ...	,, Changi 3 ..	15–18 (21*)	15–18 (21*)	—	—	Georgi and G.L.T., 1940.
,, ...	,, ,, ..	—	—	—	18–24	Holman, 1940.
Zanzibar ..	,, Amani clone	30	—	—	—	Zanzibar Rept. for 1941.
Tanganyika ..	,, ,, ,,	—	—	—	30–36	Amani Rept. for 1937.
	,, ,, ,,	24	—	42	34	Worsley and Rogers, 1941.
Ceylon	*D. elliptica*	—	22*	28	22	Ceylon Rept. for 1934 and 1935.
	D. malaccensis ..	—	14	27	26–27	Ditto.
Dutch East Indies	*D. elliptica*	—	—	—	18–24	Holman, 1940.
Puerto Rico ..	*D. elliptica* Changi 3 and Sarawak Creeping ..	18–24*	—	—	18–24	Moore, 1943.

*Decrease thereafter. †Later increases contain too much undesirable thick root.

It is true that derris root, apparently of all types, as grown in Malaya, varies widely in diameter and that a proportion of it has to be rejected. Georgi & Curtler (1929) recorded that only roots thinner than a pencil ($\frac{1}{4}$ inch in diameter) were acceptable on the London market, the ether extract in these "coarse" roots being only about half that in the "fine". The proportion of unacceptable "coarse" root might be as much as one-third at 27 months. Also, adventitious stem roots have been found to be much inferior in toxic content to "ordinary root" (Belgrave in Malaya Report for 1938). From Georgi, Greig & Gunn Lay Teik (1936) it appears that the definition of "fine" or "marketable" root has now been relaxed to include all not exceeding $\frac{1}{2}$ inch in diameter: but larger ones have to be discarded (Anon., 1934).

Also in the Philippines it has been reported that derris roots (species not stated) of "at most 1 cm." (0.4 inch) in diameter contain more active principle than bigger roots (Adriano *et al*, 1934), but this conclusion does not seem justified by the analyses given by these authors.

In *D. elliptica* in Java, Koolhaas (1938) found that roots 1–2 mm. in diameter (less than $\frac{1}{10}$ inch) had the highest toxicity—in the plants he used, 9 per cent rotenone and 22 per cent ether extract. Toxic content decreased with increasing size and roots 10–17 mm. (0.4–0.7 inch) in diameter had only 4 per cent rotenone and 14 per cent ether extract.

On the other hand, *D. malaccensis* in Ceylon (Report for 1933) gave practically the same total ether extract (21.9 and 20.2 per cent) in roots of $\frac{1}{4}$ and $\frac{1}{8}$ inch diameter respectively, but much less in roots of $\frac{1}{16}$. Moreover, it is very noteworthy that in East Africa it has not been necessary to reject any part of the local *D. elliptica* root at $2\frac{1}{2}$ to 3 years old (though of course "knob" or "collar" should not be included). Hardly any of the root exceeds $\frac{1}{2}$ inch in diameter and, in contrast to the foregoing findings, toxic content does not decrease with diameter. Worsley (in Amani Report for 1934/35) recorded 9.41 per cent rotenone for "coarse roots", 7.49 per cent for "fine". Unfortunately the thicknesses were not specified. Imperial Institute analyses of Amani roots not exceeding about 1/20 inch in diameter gave 8.7 per cent rotenone and of roots about $\frac{1}{4}$–$\frac{1}{2}$ inch 8.4 per cent (Anon., 1940 b).

For Puerto Rico *D. elliptica* the latest findings are that roots less than 1/32 inch in diameter (i.e. less than 1 mm.) are relatively low in rotenone, which increases with diameter up to about $\frac{1}{4}$ inch and thereafter decreases (Moore, 1943). It is stated that this decrease

is not due to loss of rotenone but to increase in starch accumulation in the larger roots; and Moore also draws attention to the variability in rotenone content—up to double—between roots of the same diameter in the same plant.

Type of soil and rate of growth have both been reported as affecting type of root produced. Even within selected Changi 3, soil may cause production of either light hairy roots or fleshy roots (Holman, 1940). In Puerto Rico (Mayaguez Report for 1939), "root form, especially in *Derris elliptica*, was considered a general guide to growth and incidentally to chemical composition. Some roots were definitely tapering, others were practically cylindrical, and many did not fall readily into either class. The two extreme types were most easily detected in roots less than 5 mm. in diameter. The tapering form of root in this diameter range grew directly from the parent cutting or base of older vines into the superficial layer of the soil where repeated and severe drying was unfavourable to growth. Such roots tended to be high in starch and relatively low in rotenone". It has also been recorded (*ibid.*) that in *D. elliptica* St. Croix type "the tissues of fresh roots with a high proportion of resin cells cut easily and yielded a considerable quantity of white sap, while tissues high in starch were relatively woody and yielded only a trace of sap".

No studies of the distribution of derris roots, by depth and type, appear to have been reported except for *D. elliptica* Sarawak Creeping in conditions not usually selected for derris-growing on a heavy black soil with a relatively high water-table (Mayaguez Report for 1939).

The Effect of Manuring

There is no doubt that, for ease of digging, derris should be grown in sandy or sandy-loam soil. It has also been stated, e.g. most recently by Sievers and Higbee (1943), that derris grows best on rich, as well as well-drained, soil. As will be seen below, there is some evidence, especially from East African field results (section 9), that derris in general is remarkably undemanding and that poor soil may grow it excellently.

Before dealing with the published results of manurial trials two ancillary investigations may be mentioned.

In Malaya, Georgi, Greig and Gunn Lay Teik (1936) have reported the results of analysing complete plants. They used plants of *D. elliptica* Sarawak Creeping and two varieties of *D. malaccensis*. They found wide variation, but conclude that their "figures shown no specific differences in the amounts of the principal plant nutrients in the various species". They averaged their results for all species and on a basis of 3 × 3 spacing estimated that a crop of *D. elliptica* removed, per acre, 82.3 lb. nitrogen, 19.3 lb. phosphorus (as P_2O_5), 55.3 lb. potassium (as K_2O), 46.3 lb. calcium (as Ca O) and 6.4 lb. magnesium (as Mg O). These results will naturally vary very widely according to the size of the individual plants.

Worsley (Amani Report, 1938) described sand-culture experiments with *D. elliptica* Amani clone, in which the nutrient solutions were varied. The results were surprising: "almost complete" deficiencies of potash and 95 deficiency of nitrogen gave no less root than full nutrient; "almost complete" deficiencies of calcium and of phosphorus reduced the yield of root to one-half and one-fifth respectively. The percentage of rotenone in root grown in full nutrient was only half that in root grown in deficient solutions. He concluded that "derris is likely to give a more toxic root in soil poor in potash or nitrogen than in rich soil", and that severe shortage of calcium or phosphorus affects the yield, while shortage of potash and nitrogen need not.

Accounts of field manurial trials are without exception unsatisfactory in one feature or another. None of them gives an adequate description of the "control" soil, nor quotes its pH. The latter is of much potential interest in view of the foregoing paragraph.

The only Java trials recorded seem to be those with *D. elliptica* Toeba poetih Cl. 1 discussed by Huitema (1938). At Buitenzorg additions of lime, in the form of "marl" at the rate of a little under 1½ tons to the acre, raised the yield of dry root "definitely" [? significantly] from 390 to 460 kg. (say, from 840 to 1,020 lb.) per acre. Sulphate of ammonia at about 2 oz. per plant was ineffective by itself and practically so with the "marl". In a trial on "old andesite-laterite" poor in potash, plants given potash (quantity not specified) "appeared stronger to the eye" than the controls, but were not then ready to dig. Both Maas (1935) and Dijkman (1941) think potash and phosphorus are more important requirements of the derris plant than nitrogen, but the basis of their belief is not clear.

Experiments reported in the Philippines with liming cannot be interpreted and in any case are incomplete (Philippines Report, 1938, 1939). In Puerto Rico the application of "fertilizer" is mentioned as standard practice, but its composition is not given and no study of the requirements of derris in this respect has been done (Moore, 1943).

At Amani an "observational trial" with dung, compost, lime and superphosphate gave "no very large increase in yield over controls" (Worsley, 1940).

It is unfortunate that the manurial trials in Malaya have not been satisfactorily arranged and reported. Georgi, Greig and Gunn Lay Teik (1936) give the results of (*a*) "manured twice" and (*b*) "manured and limed" plots of *D. polyantha*? *D. elliptica* (Singapore type), *D. elliptica* Sarawak Creeping, *D. elliptica* (Serdang type) and *D. malaccensis* var. *sarawakensis*. It is expressly stated (p. 276) that "strictly speaking, statistical methods are inapplicable", but, nevertheless, the summary reports that "the yields from the manured and limed sub-plots were significantly better than those from the controls". This is grossly misleading, since for *D. elliptica* (Singapore type) Table IV shows average air-dry weights of roots (*a*) "manured twice", 0.16 lb., (*b*) "manured and limed", 0.18 lb., (*c*) "control", 0.18 lb. No clear statement is made on the result of manures without lime: the pronouncement that "the figures . . . . show no significant interaction between derris and manures" is of no practical value whatever, even if correct, since the material is derived from five different types and three different botanical species. In view of the foregoing it is surprising to find that three years later Georgi, Lucy and Gunn Teik (1939) quote the results of the work reported in the 1936 paper as having "showed that the application of artificial manures with and without the addition of lime caused significant increases in yield of root".

In subsequent trials Georgi, Lucy and Gunn Lay Teik (1939) found an increase from 597 to 1,000 lb. (calculated) per acre in root-yield of *D. malaccensis* var. *sarawakensis*, lime at half a ton an acre being "the most economical treatment". But with *D. elliptica* Sarawak Creeping they got no significant increase in yield. With the same type of derris Puerto Rico also found that ammonium sulphate did not increase yield (Mayaguez Report for 1939).

On the whole it may be gathered from the foregoing that *D. elliptica* in general is unusually unresponsive to manuring and no increases in root yield seem to have been obtained for any type of this species except with lime. There seem to be no reports of trials with Changi 3. No manuring has altered the toxic content of any type of derris (though a deficiency of potash or nitrogen may increase it).

In view of these facts it is difficult to understand why it has recently been stated as a generalization for Malaya that "manuring is required except on virgin soils and a basic fertilizer is recommended" (Holman, 1940, p. 60). This may be derived from the obsolete, and in any case more tentative, statement in Malayan Leaflet No. 1 (Anon., 1934).

It may, however, be noted that apparently also in Formosa manuring—in that case organic—is regarded as routine. "The soil in the region devoted to derris requires only fish meal to give good results" (Boehringer unpubl. *cit.* Sievers, 1940). The good effects are presumably on yield, since Ishigai (1937, *cit.* Sievers, 1940) states that organic manures have been found not to affect toxic content in Formosa; and the good effects of fish-meal in Formosa will, if the soils are low in phosphorus, be in agreement with Worsley's experimental result that severe shortage of phosphorus depresses yield.

It may be noted that, as might be expected in a leguminous plant, nodules are occasionally present on the roots of derris. Experiments had been begun in the Philippines (Silayan, 1940 a), to ascertain the effects of inoculation with cultured nodule organisms, but no results had been obtained in the latest reports available. Moore (1943) has stated that in Puerto Rico "derris does not respond to heavy applications of ammonium sulphate, but that it develops an abundance of nitrogen-fixing nodules on the roots". On the other hand, in East Africa Worsley (1939) records that derris plants "rarely produce nodules: possibly only when there is a nitrogen deficiency in the soil".

The possible importance of some of the "minor elements" has been investigated in Puerto Rico (Mayaguez Report for 1939) and as a result the derris plant was found to be sensitive to iron deficiency. The experiments were conducted with soil containing a large proportion of iron oxide, practically none of which was available to the plant owing to alkalinity. Iron deficiency is not likely to occur on any of the East African derris areas.

TABLE 5
AVERAGES PER PLANT AND YIELDS PER ACRE OF AIR-DRY MARKETABLE ROOT

Country	Type of *D. elliptica*	Per plant	Per acre	Spacing	Reference
		Oz.	*Lb.*	*Feet*	
Formosa	Not specified	—	1,850	—	Holman, 1940.
Philippines ..	,, ,, ...	(5·7)	1,800	3×3	Adriano *et al.*, 1934.
,, ..	D9	9	—	—	Silayan, 1940a.
,, ..	Pilipogon	5	1,568	3×3	(Philipp. Rept. for 1936; Holman, 1940.)
Dutch East Indies	Not specified	8–12	—	—	Koolhaas, 1934.
,, ,, ,,	,, ,, ...	15	—	—	Anon., 1936 b. *cit.* Sievers, 1940.
,, ,, ,,	,, ,, ...	(4·5)	1,364	$3\frac{1}{4}\times3\frac{1}{4}$	Maas, 1935.
,, ,, ,,	,, ,, ...	(8·5)	937	5×5	Maas, 1935.
,, ,, ,,	,, ,, ...	8	—	—	Legros, 1937.
,, ,, ,,	Toebah poetih clone 1 ..	(3·4)	850	$3\frac{1}{4}\times3\frac{1}{4}$	Huitema, 1938.
,, ,, ,,	,, ,, ...	(5·8)	700	$3\frac{1}{4}\times6\frac{1}{2}$	Huitema, 1938.
,, ,, ,,	,, ,, ,,	(9·1)	545	$6\frac{1}{2}\times6\frac{1}{2}$	Huitema, 1938.
Ceylon	Not specified	—	874 at 22 mths. 1,742 at 28 mths.	—	Ceylon Rept. for 1934.
Malaya (lowlands)	,, ,, ...	—	1,060	3×3	Georgi and Curtler, 1929.
,, ,,	,, ,, ...	—	800–1,200	—	Anon., 1934a.
,, ,,	Sarawak Creeping ..	—	1,955	—	Georgi, Lucy and G.L.T., 1939.
,, ,,	Changi 3, three clones at Kuala Lumpur ..	2·2–32 at 24 mths.	—	3×3	Georgi and G.L.T., 1940, Table IV.
,, ,,	Changi 3, three clones at Serdang	14–19 at 24 mths.	—	$6\times\frac{1}{4}$	Georgi and G.L.T., 1940, Table I.
,, (highlands)	Not specified	8	—	—	Bunting and Milsum, 1930.
Sarawak	Sarawak Creeping ..	(3·5)	1,000–1,200	$3\times3\frac{1}{2}$	Holman, 1940.
Puerto Rico ..	Sarawak Creeping ..	(3·3)	1,321	$2\frac{1}{2}\times4$	Puerto Rico Report for 1939.
,, ,, ..	,, ,, ..	(2·5)	1,010–1,117	2×3	Moore and Jones, 1943.
,, ,, ..	,, ,, ..	—	900	$1\times3\frac{1}{2}$	Moore, 1943.
,, ,, ..	,, ,, ..	—	920	$2\times3\frac{1}{2}$	,, ,,
,, ,, ..	Not specified, unstaked	—	885	$3\times3\frac{1}{2}$	,, ,,
,, ,, ..	,, ,, staked ..	—	885–1,738	—	,, ,,
,, ,, ..	,, ,, ...	—	3,040	—	,, ,,
Tanganyika ..	Amani clone	8·4	1,443	4×4	Hill, 1940.

SPACING AND YIELDS

(*a*) *Published data.*—It might be supposed that with statistics of exports and of acreage under the crop in various countries some deductions might be made about yields per acre. Several reasons made this course impossible: some of the derris is interplanted, some sole-crop; much is produced in small patches by peasants; much is consumed within producing countries; and there may be a very large carry-over of stored root from year to year as in Malaya in 1938 (Holman, 1940).

Actually the data on yields are very scanty and very unsatisfactory. Some of the best published data available are brought together in Table 5, though in most cases there is no possibility of gauging how accurate and critical the basis may be. Except where stated in the table, the figures quoted are assumed to be for derris of the normal age for local harvesting and subjected to no unusual treatment. The weights are of air-dry marketable root. This is the basis usually adopted by authors, but in a few cases I have had to reduce fresh weight to air-dry by taking 50 per cent as the loss on drying. It may, however be up to 58 per cent (*see* Georgi and Curtler, 1929). Those figures in brackets are calculated by me from yields per acre or hectare and the spacing.

It is not quite certain that the figures from the Dutch East Indies relate to marketable root: probably they do, since no reference has been traced in the local literature to the routine rejection of a proportion of the "coarse" root as happens in Malaya.

It will be noted that the yields quoted from Huitema, from replicated trials, and hence presumably ascertained with accuracy, are much lower than most of the other yields in the table. They may not be exactly comparable, because the plants were dug at 24 months and Huitema (*ibid.*) gives evidence that the weight of the root more than doubles between the ages of 18 and 30 months.

I must confess to some doubts about the reliability of the figure of 15 oz. per plant given in one reference for the Dutch East Indies, both because it was published in an anonymous article and because I have not been able to examine the original. I include it as a matter of interest and because it has been reproduced by Sievers (1940).

Special attention is directed to the great difference between the average yields in the Changi 3 clonal experiments at Kuala Lumpur and Serdang respectively. The paper from which these figures are extracted suggests no reason why the yields at Kuala Lumpur never exceeded an average of 3.44 oz. for any 10 plants at 24 months old, while at Serdang groups of 10 averaged 8.51 at 18 months, 14.77 at 25 and 19.53 at 25 respectively. Since the spacing was only 3 × 3 at Kuala Lumpur, but 6 × 4 at Serdang, this might naturally occur to the reader as a possible cause. This possibility does not seem to have been considered in the paper, though there is the following comparison: "There is no corresponding increase in the average weight of root for an individual plant of a vegetative progeny of this race of derris at a wider spacing compared with the more closely spaced parent plant at the same age". This is immediately followed by the sentence: "Wider spacing does not therefore necessarily result in an increased yield of root per plant". This is an unwarranted extension of generalization. The plants compared did not even belong to the same generation, planted in the same season.

As Huitema (1938) has pointed out, actual yield per unit of area may not be the sole determinant in deciding on a spacing. He got the same weight of root per unit of area from 3 × 3 ft. as from 3 × 6 ft. spacing, but with double the number of plants in the former arrangement both nursery and digging charges were higher. On the other hand in Puerto Rico, where no significant differences in yields per acre were found for spacings 1 × 3½ ft., 2 × 3½ and 3 × 3½, there is actually a tendency to prefer the closest spacing because weeding is reduced (Moore, 1943).

There is a lack of adequate spacing trials. In East Africa, Worsley and Rogers (1940) have reported that a "preliminary trial" (not planned for statistical interpretation) at 2 × 1½ ft. gave 3.2 oz. per plant (equivalent to 2,900 lb. per evenly spaced acre) against 8.4 oz. per plant at 4 × 4 ft. spacing (equivalent to 1,443 lb. per evenly spaced acre). These authors also state that "experience at Amani suggests" that a spacing of 2 × 2 ft. is "near the optimum".

(*b*) *Unpublished data.*—Derris has been planted at Amani on a commercial scale each year since 1936 and harvested at 30–40 months, but for several reasons no strictly comparable data for yields per plant or yields per acre are available. Some plants have had a heavy crop of cuttings taken off them; most have been staked, but some have not; some have received various manures and doses of compost in the course of "observational" trials and some have not; some were interplanted in permanent crops and some were not. Consequently each year's root yields are derived from plants that have received a variety of treatments. Moreover the system of interplanting or of planting the derris in beds makes it difficult to calculate an accurate "yield per acre". The spacing in the beds is known, but the border effect is great, and is variable since the paths between the beds vary in width on different sites. Nevertheless, the average yields per plant are of interest, and have been worked out by Mr. L. R. Doughty from the plantation log-books. The details are given in Table 6, with the addition of yield figures kindly given us by estate owners.

Since 2 × 2 spacing gives about 11,000 plants to the acre the number per acre actually obtained in the Amani plots, allowing for spaces between beds, is at least 9,000, and the yield per acre at 3.7 oz. per plant is about 2,100 lb. This, it will be observed, is higher than any published figures for yield elsewhere (Table 5) and is, moreover, of root containing at least 8 per cent rotenone.

These satisfactory results are obtained with a rainfall that by Far Eastern standards would be regarded as adequate, but with temperatures that would be considered low (*see* section 4). To account for the excellent results, exceptionally favourable soil might therefore be expected. The evidence is rather to the contrary. No exact details are available for the soil of the actual derris plots, but the soil of the whole Amani area, which is derived from hornblende-biotite-gneiss and highly leached, can be described as poor and acid. Most of the plots consisted of sandy clay (highly laterized) and some of them were of almost pure sand. In a number of soil samples from the locality the pH ranged from 4.3 to 5.9 and the following average values were obtained:—

Exchangeable CaO—2·1 milligram equivalents per cent.
K_2O—0·05 milligram equivalents per cent.
Organic carbon—2·6 per cent.
Total nitrogen—0·16 per cent.
Readily available P_2O_5 four parts per million.

On this basis it appears that the Amani derris has for the most part been grown in soil that is extremely deficient in, among other things, calcium, potash and phosphorus. The rather unsatisfactory data on the nutritional requirements (section 8) actually indicate that

severe shortages of calcium and phosphorus are bad for yield, though the poverty of the soil in other respects may favour high toxicity.

In Table 6 the extraordinary yield of 35 oz. per plant will be noticed. No explanation is at present forthcoming. In this small derris plantation the "wet" weight of one root is stated to have been 7 kg. (over 15 lb.).

TABLE 6

UNPUBLISHED YIELD DATA (East Africa—*D. elliptica* Amani clone)

Locality in Tanganyika	Alt. a.s.l.	Dry weight		Spacing	Remarks
		Oz. per plant	Lb. per acre		
	Feet	*Oz.*	*Lb.*	*Feet*	
Coast	100	10·3	—	—	A small planting. Many "misses". Very sandy soil in area with rainfall about 40 in. per annum.
Near coast	300	5·4	880–1,000	$3 \times 1\frac{1}{2}$	Yield is actual. Spacing is nominal; misses so numerous that effective spacing much increased.
West Usambara ..	2,400	35	—	$6\frac{1}{2} \times 1$	About 40 months old.
East Usambara ..	3,000	(4·0)	1,000	$3\frac{1}{2} \times 3\frac{1}{2}$	Only about 4,000 plants per acre survived.
Amani, 1937, planting	3,000	5·2	—	$2 \times 1\frac{1}{2}$	In beds, some manured.
,, 1938 ,,	3,000	2·7	—	$2 \times 1\frac{1}{2}$	In beds. Staked. Some losses through flooding.
,, 1939 ,,	3,000	3·8	—	2×2	In beds. Staked.
,, 1940 ,,	3,000	3·7	2,100	2×2	In beds or on contours, staked.

PROPAGATION BY CUTTINGS

There is much variation in the ease with which derris cuttings can be struck, even within the species *D. elliptica* and within the Changi type of that species.

In the Philippines it appears that successful rooting of not more than two-thirds of cuttings from the locally selected *D. elliptica* could be reckoned on. In experiments "slant" planting gave 67.33 per cent success against 63.33 per cent in "horizontal": doubtless the difference is not significant, but the rooting of the slants is said to have been "much more accelerated".

It is surprising that such poor success with cuttings should have been attained in the Philippines since in Malaya a number of years ago 90 per cent success in four to six weeks was counted on (Malaya Report (Tech.) for 1930). It may be that at lower temperatures special measures are needed. Sievers (1940) has explained the Japanese technique in Formosa, where it is held that "the minimum temperature tolerated is 10°C.".

One of the advantages of Changi 3 is its ready growth from cuttings, and this is shared by the Amani clone, with which, as a rule, over 90 per cent success is achieved at Amani. This, however, seems to depend partly on the choice of woody cuttings with short internodes (Amani Report for 1938; cf. also Ishigai *cit.* Sievers, 1940); softer cuttings with longer internodes, such as have been obtained from staked plants, are less satisfactory. It appears too that in Puerto Rico the rooting-success of Changi 3 cuttings cannot be so good as in Malaya, otherwise the discovery of a strain in St. Croix with "a much greater capacity to establish themselves under adverse field conditions" would not have aroused such interest (Mayaguez Report for 1939). Experiments showed that, as expected, large and medium cuttings (about 0.4 to 0.8 inch in diameter) were the best and also that cuttings with only 1 inch exposed above the soil rooted most quickly.

It has been found at Amani (Report for 1938) that introduction of derris root-sap and stem-sap into green cuttings by both injection and suction does not improve their rooting. Glover (1938) found, however, that cuttings treated with the growth-promoting substance, beta-indole-acetic-acid, produced significantly more roots in the two-months' period of the experiment than untreated cuttings. Subsequent field experiments, dug at $3\frac{1}{2}$ years after planting, showed, as might be expected, no significantly better yields at that age with hormone-treated plants than with the controls (unpubl.).

STAKING

In the Philippines, it has been reported (Philippines Report for 1936; Silayan, 1940 a) that plants (of *D. elliptica*) supported on trellises gave a higher yield than unsupported plants, and also provided more stem cuttings. In one trial supported plants averaged 335 gm. (= 12 oz.) of root, apparently fresh weight, equivalent to about 6 oz. dry, against little more than half that yield from un-

supported plants. The supported plants developed roots that spread more in all directions, including downwards, and the method appears by 1940 to have been regarded with some disfavour because the deeper roots made harvesting more difficult and expensive.

Experiments in Puerto Rico (Mayaguez Report for 1939) indicate a possibility that this object may be off-set by the deeper roots being richer in rotenone than the superficial ones. In local practice, however, the supporting of the plants on trellises is regarded as doubtfully economic (unless the maximum number of cuttings is required), even though supported plants may yield much more root—3,040 lb. per acre against 885–1,738 in one experiment (Moore, 1943).

In the Dutch East Indies staking is recommended, since a 30 per cent increase in root is claimed to result (Milsum and Georgi, 1937). However, it is pointed out (*ibid.*) that against the value of the increase must be set the extra cost of weeding as well as the cost of staking.

At Amani it was at an early stage decided that staking was beneficial. Worsley and Rogers (1940) reported, on the basis of an observational trial, that staking increased the yield of *D. elliptica* (Amani clone) by about 60 per cent. Subsequently, Worsley (1941) stated that in further trials staking had given a "highly significant" increase of 67 per cent in weight root at three years old. The conclusion was that "under normal conditions an increase of this magnitude would more than cover the cost of staking, especially as with plants spaced 2 × 2 ft. one stake would suffice for four plants".

The advantages of staking cannot, however, be regarded as proved. As Mr. L. R. Doughty has remarked (unpubl.), although the difference is very large and may indicate a real increase as a result of staking, the lay-out of the experiment was not such as to eliminate the fertility factor and, strictly, it was not susceptible of statistical treatment.

Incidentally it may be remarked that the roots of staked plants at Amani go deep, in fact down as much as 3½ feet. A minor undesirable effect of staking is that the cuttings from staked plants tend to be more difficult to establish. This is due to two factors: firstly, the stems of plants trailing along the ground often produce from the nodes adventitious roots that serve to give the cutting a good start; secondly the stems of staked plants tend to be softer, with much longer internodes.

All the foregoing discussion relates to the effect of staking on yield of roots and cuttings. The only reference traced to any effect on toxic content is that in Silayan (1940 a), where 4.35 per cent rotenone is said to have been obtained from staked plants against 3.15 per cent from unstaked. The contents are in any case uneconomically low and there is no evidence that the plants were at the best age for digging or that the results were statistically significant.

Pests and Diseases

In the Far East pests of the derris plant are numerous, and in parts of Malaya so serious as to stop estate cultivation (Malaya Report for 1930–1932). Most of the records of pests have been collated by Roark (1939). In East Africa pests of the living plant seem to be of negligible importance and no records of any have been published. Plants suffering from drought are, however, liable to be attacked by termites (M. T. Boscawen *in litt.*).

Diseases are not serious in any derris-growing area and are perhaps about as important in East Africa as in the Far East. *Armillaria mellea* has caused appreciable losses in Usambara (Amani records, unpublished). *Fomes* sp. has been reported on a diseased plant from Tanga District (G. B. Wallace, unpubl.). In Uganda (Report for 1937–38) *Diplodia* and *Fusarium* have been recorded on diseased cuttings, but this trouble has been diminished in recent years (C. G. Hansford *in litt.*).

For an insecticidal product, stored derris root is remarkably susceptible to insect damage. There have been many references to this in Malaya (*see* especially Miller, 1934 a, 1934 c) and it is by no means unknown in East Africa. In one case the Bostrychid beetle, *Xyleborus capucinus*, was the cause (W. V. Harris *in litt.*).

Histology and Biochemistry of Rotenone in Derris Plants

Though Maheu (1925) and Youngken (1931) had previously investigated the histology of derris roots, Van der Laan (1936), Worsley and Nutman (1937) and Castagne (1937) appear to be the first to have given an account of the localization of rotenone in the root. Worsley and Nutman observed that in *D. elliptica* starch and rotenone do not occur in the same cell, but in mutually exclusive groups; and, further that "at no stage are the rotenone cells structurally specialized. They appear to be per-

fectly normal parenchyma. If sections of roots of any age are cleared from rotenone by alcohol it is impossible to distinguish the cells that have contained rotenone". This is here quoted in full because of the misleading statement in *Bull. Imp. Inst.* 39: 248 (1941), which purports to quote from the Puerto Rico (Mayaguez) Report for 1939, that the rotenone "is restricted to so-called resin cells, distinct both in appearance and function from the starch-storing cells of the parenchyma". In fact, however, the Mayaguez report observes only that Worsley and Nutman found the "fundamental parenchyma 'to consist of' two functionally different types of cells", and investigations at Mayaguez supported the view that rotenone and starch are "found in mutually exclusive cells". These conclusions have been confirmed by Gunther and Turrell (1942), who incidentally draw attention to the probable toxic importance of the saponins in *Derris* spp.

The work of Worsley and Nutman was extended by Worsley (1939) into an investigation of the localization of rotenoids in "all available parts at all available stages of growth" of *D. elliptica*, and three other species of *Derris*. He discussed the probable biochemistry of rotenone formation. It was noteworthy that *D. elliptica* plants kept in the dark until dead showed no reduction in the percentage of rotenone, thus indicating that rotenone is not available as a food reserve. This was confirmed by Puerto Rico experiments (Mayaguez Reports for 1938 and 1939) in which plants were severely pruned until they "had reached a stage of acute carbohydrate starvation".

The work of Llanes (1940) appears, from the extracts available, to have been concerned only with the histology of rotenone (in Philippine derris); but of recent years the study of its biochemistry as well as its histology has proceeded actively in Puerto Rico. Marked variations, not previously reported, were observed in the general patterns of resin-cell and starch-cell parenchyma. There was a distinct tendency for the two types to predominate in concentric bands. Evidence has been obtained at Mayaguez that the laying down of tissue with a high proportion of rotenone cells is associated with flushes in the aerial growth of the plant. Moreover, "roots growing in the superficial layers of the soil, where conditions are unfavourable owing to frequent severe drying, proved to be rich in starch but poor in rotenone" (Mayaguez Report for 1939). Subsequently it was reported that in greenhouse experiments in Puerto Rico plants of *D. elliptica* (Changi) St. Croix strain, "forced to grow rapidly by the application of an abundance of fertilizer and water, with some reduction of light, stored 3.9 times as much rotenone in their roots as plants that were retarded", as well as producing 4.9 times the weight of the root (Moore and Jones, 1942; Moore, 1943).

From this it might be inferred that the commercial production of high-rotenone derris-root requires well-distributed, if not also high, rainfall. In East Africa this does not hold good, as between the Usambaras and the coastal strip, where the rainfall is much lower and more unevenly distributed (*see* Tables 3 and 6); but it is a factor that may operate in the still more extreme climates of the Northern Province of Tanganyika and of Nyasaland.

Summary

The published data, with the addition of some unpublished for East Africa, are reviewed under the following heads: selection and breeding (with a table showing the toxic contents attained); variability; climate and derris; shade; the age for harvesting; root character and toxicity; the effect of manuring; yields and spacing; propagation by cuttings; staking; pests and diseases; histology and biochemistry of rotenone in derris plants.

On the whole results and opinions are remarkably inconclusive and conflicting. There is a wide field for carefully planned experimentation.

The Tanga Province of Tanganyika Territory is at present practically the only producer of high-grade derris root in the British Empire. Production and prospects elsewhere are mentioned. The Tanganyika derris industry is based on clonal material of *D. elliptica* Changi type, with satisfactory toxic content, but not nearly so good as the more recent selections in Java and Malaya. Commercial production in Tanganyika is all in climates cooler or drier, or both, than thought desirable in the Far East. Maturation is much slower than elsewhere, so that harvesting is not recommended before 30 months, compared with 18–24 elsewhere. Excellent yields have been obtained on soils, as well as in climates, that would, on experience elsewhere, be classed as unfavourable.

(*To be continued*)

ORIGINS OF SOME EAST AFRICAN FOOD PLANTS
PART III

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Institute, Amani

FRUITS USED AS VEGETABLES

BITTER GOURD, *Momordica charantia* L. *Karela.* This is widespread in the tropics and sub-tropics and its original home is thought to be in the Old World. Its fruits are sold on Zanzibar markets and are used in curries. Its Swahili name has been derived from the Indian *kerala* and its use as a food may have been learnt by the East African coastal peoples from the Indians.

CLUSTER BEAN, *Cyamopsis psoraloides* DC. Native of India, introduced into Tanganyika in 1910, but not established. It has recently been reintroduced into East Africa and has not yet passed out of the experimental stage. The young green pods are used as a vegetable.

CUCUMBER, *Cucumis sativus* L. *Mtango,* the fruit *Tango.* A cultigen* of unknown origin in either S. Asia or Africa; no wild prototype has been found. It was in Egypt in time of the XIIth Dynasty and was known to the Greeks and then the Romans throughout the eastern Mediterranean and was recorded in China at the beginning of the sixth century A.D. It is occasionally found wild in East Africa, but most of the cucumbers grown for their fruits are probably of recent introduction.

EGG PLANT, BRINJAL, *Solanum melongena* L. *Mbilingani, Mbilinganya.* This is a native of south-eastern Asia, now cultivated throughout the warmer parts of the world. It is cultivated in some places along the East African coast, in Zanzibar, in Uganda, Kenya and Nyasaland, and is believed to have been brought to East Africa by the Persians from the Persian Gulf or India. Up-country it is usually associated with Arab settlements. There are many races, some of which have been introduced in the last and during the present century by Europeans.

GOURDS, CALABASH, BOTTLE OR CLUB GOURDS, *Lagenaria vulgaris* Seringe. *Mmumunya, Mmungunya* or *Mumunie.* This plant is found wild in India, but is believed to be originally African. According to Chevalier it is only one of the cultivated plants common to America and Africa which was equally present in both continents prior to Columbus. One authority goes so far as to say that it was originally Asiatic and could have been carried by ocean currents. Drift fruits of what were said to be *L. vulgaris* were found in the eighteenth century in the beach-drift in Norway, but doubt has since been cast on the correct identity of these fruits and it has been suggested that they were those of a *Crescentia* (Bignoniaceae), a Central American genus. I have been unable to trace how long *Lagenaria* seeds will remain viable, but cucumbers and pumpkins retain their vitality for over fourteen years. If this drift theory is correct and *Lagenaria* seeds are long-lived, it is possible that the plant spread to America from Africa or India in this way. The young fruits are eaten as a vegetable; the shells of the mature fruits are used as bottles.

LOOFAH, *Luffa cylindrica* (Lour.) Roem. *Madodoki, Mdodoki, Mtango kima* and *Uziuzi.* This is a native of the Old World tropics and is cultivated all round the world. It is of such ancient cultivation that it is not possible to say whether it is African or Asian in origin. Its young fruits are eaten as a vegetable and the fibres in the dried fruits can be used as a sponge. *L. acutangula* (L.) Roxb. is another species, it is wild in India, and has now been recorded in Zanzibar and is sold in native markets there.

PUMPKIN, MUSK MELON and VEGETABLE MARROW. The pumpkin, *Cucurbita maxima* Duchesne. *Mboga.* The genus *Cucurbita* now contains about twenty species, most are American. Opinions differ as to the country of origin of the pumpkin, *C. maxima,* the musk melon, *C. moschata* Duchesne, and the vegetable marrow, *C. pepo* L. One authority thinks them "probably Asiatic", whilst the latest view is that they are all American and that both *C. maxima* and *C. pepo* were taken to the Old World promptly after the discovery of America. There is no record of the date or route.

OKRA or LADY'S FINGERS, *Hibiscus esculentus* L. *Mbamia.* The original home of this plant is not known, but it is suggested that it is African and was taken at an early date from Africa to America by the Portuguese. It was described in Egypt by Abul Abbas el Nabati in A.D. 1216 and is figured by the Italian physician and botanist, Prosper Alphinus (1553-1617), in 1592 in his Egyptian plants, although it does not appear to have been in Egypt before the arrival of the Arabs. It is recorded as wild in Uganda and the Acholi and Madi plant it on a large scale.

TOMATO, *Lycopersicum esculentum* Mill. *Mnyanya.* This is found in the warmer parts

* Cultigen, a plant, group or series, only known in cultivation.

of America, but is believed to be native of the Andes. Its introduction into Europe was probably due to the Spaniards, who also took it across the Pacific to the Philippine Islands. Rumpf said two races of it were established in eastern Malaysia and freely cultivated in his time, 1653-1692. It may have been introduced into East Africa by way of India late in the seventeenth or during the eighteenth century, but I am doubtful if their progeny would have survived to the present day. Those now in cultivation are of recent introduction and if left to themselves gradually degenerate into the small orange-yellow cherry-like tomato, *Mnyanya tungulu,* that one sometimes finds near native villages or for sale on native markets.

NATIVE TOMATO. There are a number of species of *Solanum* grown in different parts of East Africa for their fruits, which are used as vegetables; *S. macrocarpon* L. *Mkunga.* This is recorded in Uganda, Tanganyika, Zanzibar and Nyasaland; *S. sinuato-repandum* U. Damm. ex K. Braun. *Ngogwe,* in Tanganyika. Both are indigenous to East Africa. There are no doubt others, but the Solanums with edible fruits require further study than they have received up to the present.

PULSES: BEANS, GRAMS AND PEAS, ETC.

BAMBARRA GROUND-NUT, *Voandzeia subterranea* (L.) Thours. *Mkaranga, Mnjugu mawe.* This plant must not be confused with the ground-nut, *Arachis,* as it does not have an oily seed like the latter, but is starchy and nitrogenous.

Its country of origin was first said to have been Brazil and Surinam because the great Swedish botanist, Linnaeus (1707–1778), who first described it under the name *Glycine subterranea,* grew the plant at Upsala from seed sent him by Dahlberg from Surinam in 1762. Actually the plant has been found in a wild state in the north of Yola Province, Northern Nigeria, and in the Northern Cameroons. It is cultivated in other parts of Africa, but nowhere on a big scale except in Togoland and Northern Rhodesia, where many varieties are recognized.

The traveller Marcgrav, who had been in West Africa, saw it in Brazil as he was there from 1637–1644 and mentions it in his writings as *Mandubi d'Angola.* Others who recorded it were a Dutch physician and botanist, Burmann f. (1733–1793), in 1768 in South Africa, Loureiro in 1790 in Portuguese East Africa and by the French botanist, Du Petit-Thouars (1758-1831), in Madagascar and Mauritius in 1806. Thouars states that in those islands it is found only in a cultivated state, and he used its native name *voandzou helic* for its present generic name when he transferred it from *Glycine.* It is believed to have been taken at an early date from Africa to Madagascar by the Arabs. It is occasionally cultivated in India and Malaysia.

BLACK GRAM, *Phaseolus mungo* L. *Mchoroko, Mpojo.* This is a native of India and has been in cultivation there for at least 3,000 years. Its distribution to other countries has been due to Indian emigrants as it is one of their most important pulses.

GREEN and YELLOW GRAM, *Phaseolus aureus* Roxb. *Mchoroko.* The particulars given for black gram can be applied equally well to this species.

CHICK-PEA, GRAM, *Cicer arietinum* L. *Mdengu* the plant, *dengu* the seed. This is of very ancient cultivation and is believed to be a native of the Levant; its origin has been traced to *C. pinnatifidum* Jaub & Spach, found in Asia Minor, Syria and Palestine. It is an important cold-season crop in India and was probably introduced by the Indians to East Africa, where it is cultivated in small quantities.

COWPEA, *Vigna ungiuculata* (L.) Walp. (syn. *V. sinensis* Endl.) *Mkunde.* This plant has been in cultivation for so long that its country of origin is uncertain, but is believed to have originally been either Asiatic or African, and it was grown by the Greeks and Latins. Some authorities consider it to be African as some wild races have been found here. As a crop it is more highly specialized in West Africa as there are many more distinctive varieties there than in East Africa. It was taken to the New World at the very outset of transatlantic traffic, and Linnaeus gave distinctive names to the same species when he met it both from the New and Old Worlds. There are numerous races which have now been grouped into three varieties, but these were at one time considered to be three distinct species, the cowpea, with the highest proportion of races in Africa, the catjang, more common in Asia, but occurring in Africa, and the asparagus or yard-long bean, which mostly occurs in the Far East, but it has also been recorded from Ethiopia.

FRENCH *or* KIDNEY BEAN, *Phaseolus vulgaris* L. *Mahargwe, Mharagwe, Mkunde* and *Mkunde Kuu.* This is a native of tropical America, brought at an early but uncertain

date into Europe, but known to have reached England in 1594. The Spanish and Portuguese introduced it early into the tropics and sub-tropics and into Africa. There are many varieties.

HYACINTH, BONAVISTA or INDIAN BUTTER BEAN, *Dolichos lablab* L. *Mfiwi.* This plant is considered to be Asiatic in origin, where two races are known, one more or less perennial, the other biennial or annual, but which is the most primitive race and where is the place of its origin is uncertain. The Asiatic peoples distributed the races before historical times and the plant reached Egypt long ago. One authority believes it arrived in Africa about the eighth century, whilst another considers it endemic. Whatever its origin, the perennial race is now wild in many parts of East Africa and the annual race, of which there are numerous forms, is extensively cultivated by the African.

LIMA, SIEVA or MADAGASCAR BEAN, *Phaseolus lunatus* L. *Mfiwi.* This is a climber of South American origin, met with by Europeans in the neighbourhood of Lima, Peru, in the fifteenth century. The Spanish in their settlements in California brought it into cultivation and from there it has spread to all the warmer parts of the world. There are climbing and dwarf races in cultivation; there are said to be many varieties in cultivation in Tanganyika, but it is not cultivated to the same extent as the cowpea, hyacinth and french bean.

MAURITIUS or BENGAL BEAN, *Mucuna aterrima* Holland (syn. *Stizolobium aterrimum* Piper & Tracy) *Upupu.* This is said to be a native of East Tropical Africa, but its description was based on cultivated material received from Brazil and Australia. It is said to be cultivated by the natives from Central Tanganyika to Southern Rhodesia, but is not a popular pulse as it is only used in times of famine, and then only after boiling with repeated changes of water. The type is described as having shiny black seeds, those cultivated in Tanganyika as having light-grey, or light-grey and brown-mottled seeds. Investigation is necessary to find out how many species, varieties and forms there are and their value as a food. Baker enumerates eleven species in East Africa, including some in the Belgian Congo. The name *upupu* is more correctly applied to the buffalo bean or cowitch, *M. pruriens* (L.) DC., which is widespread in East Africa, its pods are covered with stinging hairs.

PEA, Garden, *Pisum sativum* L. and the Field Pea, *P. sativum* var., *arvense* Grams. *Njegere.* These are not known in a wild state, but their cultivation seems to have been to the east of Europe. They reached the Greeks via the Black Sea, and China by way of the Himalayas and Tibet. They are recorded in Arabia and in Ethiopia, and Stuhlmann suggests they were introduced into the latter country by Jesuit missionaries. In East Africa, Speke records the cultivation of peas in Kigezi, Uganda, in 1861, and their introduction to Uganda was made before the arrival of Europeans. Stuhlmann also records them at Toro, Karagwe, Ruanda, Urundi, Kasanga, the Kinga and Matengo Highlands and Songea; also in Portuguese East Africa and the Shire Highlands. He suggests that their southern distribution is due to Portuguese introductions. As they appear to have been established from the Black Sea to China at any early date, I would suggest their introduction to Africa may have been brought about through the fourth or sixth century invasions of Arabia by the Abyssinians. They are an important food crop to the natives of those areas where they have been grown for a long time. Their cultivation in East Africa is being extended to other areas above 4,000 ft. through missionaries and agricultural departments.

PIGEON PEA, *Cajanus cajan* (L.) Millsp. *Mbaazi.* This species was at one time the only one in the genus. It is said to have been found in a wild state in Angola and in the region of the Upper Nile. It has been in cultivation in Madagascar from very early times; but has never been found in a wild state in India nor is it recorded as a crop in early Chinese literature, though there are claims to it having been found both wild and cultivated in Indo-China.

Recently two other species have been added, one West African and the other Indian, so the honours are divided as to its actual country of origin, as some consider it to be African whilst others Asiatic. One theory is that it is an African development which reached India in prehistoric times. It was cultivated in Egypt in the time of the XIIth Dynasty, or some time before 2000 B.C., by which time Egypt had established trade relations with tropical Africa to the south and with Syria on the north. It is now widely cultivated throughout the tropics and was taken to the New World in the early days of traffic across the Atlantic, probably by slaves from West Africa. Its spread to the Pacific was not

very rapid as it only reached the island of Guam in 1772. This slow progress may have been because it does best in the dry tropics.

In spite of it having been recorded wild in Africa, the plant appears to be more highly evolved in India, where over one hundred types have been recognized.

There is of course no reason why its original home should not have been Madagascar, from which it may have been carried in two directions, one north-east to India and the other west to East Africa; but this suggestion presupposes an earlier state of civilization on the west side of the Indian Ocean than the evidence warrants.

Soy Bean, *Glycine max* (L.) Merr. Native of Central and East Asia and a very important pulse crop in the Far East. The first European account of it was that of the Dutch surgeon, Kaempfer (1651–1716), who met with it in Japan in 1691 or 1692. The first effort to establish this crop in East Africa appears to have been made at Amani in 1907 and further introductions were made from the U.S.A. (1909). These do not appear to have been successful, and further trials were made in 1911 with seeds from China, Japan and South Africa. Since about 1920 further trials have been, and are being, made by departments of agriculture in East Africa. It is impossible to say whether it will be established as a native food crop as the growth of soy beans is dependent on a root-bacterium with which the soil has to be inoculated, there are also other difficulties. If these are overcome a search for a quick-cooking variety will be necessary for native use as most soy beans take longer to cook than other beans. It is recorded that occasional plots of soy beans are to be seen cultivated by the natives in Uganda and Kenya, they apparently trade their seeds with Indian traders.

Tepary, or Moth Bean, *Phaseolus aconitifolius* Jacq. This is a native of India, where it is an important pulse crop on poor light soils. It was under trial in Zanzibar; in Kenya in 1932; and in Uganda. It is still too soon to say if it will be established as a native food crop.

Grains

Buckwheat, *Fagopyrum esculentum* Moench. A native of Central Asia and a recent introduction into Uganda, Kenya, Tanganyika, Northern Rhodesia and Nyasaland. It has become a popular grain food with the Mufindi native in Southern Tanganyika.

Bulrush or Pearl Millet, *Pennisetum typhoides* (L. C. Rich.) Stapf & Hubbard, *Mwele*. This grain is believed to be African in origin, although it extends into India. Bulrush or pearl millet first became known in Europe about 1566, when the closely allied *P. specatum* (L.) Koern. was raised in Belgian gardens from seeds said to have come from India, and it is still in cultivation in Spain and North Africa to-day. It has also been recorded from Manyoni District of Tanganyika.

Stapf and Hubbard in a preliminary classification of the bulrush millets distinguish eighteen cultivated races, of which eight are recorded from West Tropical Africa, six mainly from eastern and southern Africa and India, and the other four from the Anglo-Egyptian Sudan and adjoining countries.

Finger Millet, *Eleusine coracana* Gaertn. *Mwimbi* or *Ulezi*. This grain is believed to have originated from the wild *Eleusine indica* Gaertn. and appears to have been developed by selection at an early date in India as there are many varieties there where it has long been cultivated. It is believed to have been there about 1300 B.C. when the Aryans arrived. It was grown by negroes in Africa in remote times, though it does not appear to have been cultivated in Egypt. In Africa its chief centres of cultivation appear to be from Ethiopia down through Central Eastern Africa to Southern Africa. By the East African tribes it is considered to be fit as a food only for women and children, its most important use being for beer. Successive cropping of the same piece of ground with finger millet eventually leads to its abandonment through the increase of the wild *Eleusine indica*.

Italian or Foxtail Millet, *Setaria italica* Beauv. *Mawele manga*. In spite of its common and specific name this plant is not native to Italy but is Asiatic and is believed to have been cultivated before man settled enough to grow the better cereals. It is grown from Southern Europe to Japan and particularly in North China, where it is of importance to the poorer people who cannot afford to buy rice. Italian or foxtail millet is fairly rare in East Africa and is cultivated only in a few places, especially on the coast. It is not known when it was introduced into East Africa, but was probably brought in by Arab and Indian traders from Arabia by way of Muscat. There are several sub-species and many varieties; it is a quick-growing and maturing crop of the dry tropics and sub-tropics, usually grown as a rain crop.

(*To be continued.*)

TOMATO BLIGHT

By G. B. Wallace and M. M. Wallace, Department of Agriculture, Tanganyika Territory

Blight in tomato is caused by the fungus *Phytophthora infestans* which also causes Irish blight in potato. When the latter disease becomes established in a country it is usual for the tomato blight to follow, and that has happened in East Africa.

The disease was officially recorded in Tanganyika Territory in the last number of this Journal, but we are informed by Dr. R. M. Nattrass (*in litt.*) that he had observed a mild outbreak near infected potato plants in Kenya in 1942 under conditions that were, however, unfavourable for its further development.

In October, 1944, the disease in tomatoes was found in almost all tomato gardens examined along the southern slopes of Kilimanjaro at about 4,300 feet, i.e. in the potato-blight belt; at 3,400 feet the disease was absent from both crops following a five-months drought. At Lushoto in the Usambara Mountains, Mr. R. D. Linton, Senior Agricultural Officer, observed the disease in tomato seedlings in December, 1944, Our information on the occurrence of the tomato disease in other parts of Africa is incomplete, but there is at least a record from Natal in 1922. It can, however, be concluded that the disease has been rare in this continent.

Tomato is believed to get its infection from potato, and it normally occurs later in the season. The disease at its worst can be very destructive both in the field and in storage. There is evidence in the literature on the disease that at least two biological strains of the fungus occur. While there is a certain amount of information on the subject of these strains, it is not necessarily applicable to East Africa. Until more local information is obtained, it will be sufficient for our farmers and gardeners if they look upon the disease in either potato or tomato as a possible source of infection to the other. In the laboratory potato leaves were readily infected from tomato; the reverse inoculation was not invariably successful.

Factors which are likely to affect the degree of severity of tomato blight in East Africa are: elevation, climatic conditions, and the proximity of infected potato plants. The higher the altitude the more favourable will temperature and humidity be for blight. In the U.S.A. temperatures of 75° F. and over are found to check the disease, and the spores of the parasite are said to be killed by dry weather and a temperature of 80° F.

Symptoms

The symptoms should be known to the grower in order that the disease can be quickly spotted, and not be confused with other tomato diseases. The symptoms in the foilage are very similar to those in potato, but there is the fruit also to consider. All the above-ground parts are susceptible to attack. Individual leaflets will usually be infected first, followed by whole leaves, the stems and fruits. The affected leaflets show grey to brown areas, often towards the edges; in wet or damp weather these become soft and rotted and show a dust of white spores on the margin. The leaf-stalk may become brown and thin, while the leaves wilt, hang down and fall. Where the stems are affected long dark-brown areas with a wet rot appear.

The fruits are susceptible at all stages of development and decay commences normally at the stem end; it spreads towards the blossom end as water-soaked brown or chocolate-coloured mottling or blotches. The affected parts appear very glossy. When the fruit is cut lengthwise a considerable proportion of the inner tissues are seen to be brown, wet and decayed, though still fairly solid. The disease in the fruit can be readily distinguished from Blossom-end rot in which the blossom end of the fruit becomes flattened, brown and decayed; the latter is a non-parasitic disease caused by irregularity in watering.

Fruit from affected plants if stored may develop a considerable amount of rot after a few days, particularly if conditions are humid. In the U.S.A. losses of 20 to 50 per cent of fruit in transit have been recorded. Blight should not be confused with the common Grey mould and Septoria leaf-spot of tomato. The Grey mould (also called Leaf mould) shows as smaller spots which are yellow on the upper side and bear olive-coloured spores on the under side. Septoria, which is fairly common in slow growing crops, turns the leaflets yellow, then brown along the edges or in spots, and on these discoloured areas appear small dark-grey rings with pale centres bearing minute dark fruiting bodies.

Control

The first essential is to make a careful examination for the presence of the disease in any district. If blight is present in potato, the conditions are probably favourable for the

disease in tomato also. So far as possible the two crops should not be grown close together. In districts where tomato blight is endemic it would be advisable to consider growing the tomatoes at lower elevations, which though less suited to the potato might meet the requirements of tomato. A rich soil will enable the plants to resist infection. The plants should be tied up to stakes and be well spaced; this will facilitate any spraying.

Spraying may be found necessary. To be effective both surfaces must be treated and several applications given. The time for the first spray will depend upon the time of appearance of the first symptoms in the fields. Bordeaux mixture and copper dusts used for potato blight can be used on tomato. Burgundy mixture, however, at a strength of 5-6¼-50, was found at Cheshunt in England to cause considerable leaf scorch and to leave a heavy deposit on the fruit. At Wisley lime sulphur was found to be useless for blight control. The best proportions of copper sulphate to lime in the Bordeaux mixture have been variously stated, but 4-4-40 is suggested and trials might be made using less lime.

The remains of tomato plants should be collected and burned at the end of the season. Fruit to be kept packed or in transit for a number of days should first be exposed for a few days before packing to allow any blight to develop and affected fruit to be discarded. Decay in transit is said to be greatly reduced if the fruit are immersed for two minutes in commercial formalin at a concentration of one part in 300 parts of water, then allowed to stand four to five days before sorting and packing.

Throughout the meetings two powerful trends of thought can be traced which are of significance for the future of the industry. The first is the emphasis on the necessity of placing scientific work on a sound basis. This is not altogether a new note in the proceedings of the United Planters Association of South India, but this year it may be said that it acquired a new emphasis. There was a clearly expressed recognition that active research must be an integral part of the industry and that it represents a vital weapon in meeting the increased burdens which a forward looking labour policy must place on the industry in the early years, and which the post-war problems of disposal of primary produce are likely to bring. This recognition of the key position of research is an important new step and must not be lost sight of in the future. It is vital that the industry should increase its efficiency in terms of output per acre and this demands the closest critical examination of productive methods with all the weapons the scientific worker commands. In the past the research worker has been looked upon primarily as adviser when things go obviously wrong—when a disease or destructive insect appears or when areas of the crop show a marked decline in yield. It must be increasingly realized that positive health and the maximum production consistent with it is something very much more than freedom from obvious defect. This is being increasingly appreciated in the sphere of human health and well-being and it is no less applicable to agricultural production of every kind.

Extracted from *Planters' Chronicle*, Vol. XXXIX, No. 18, September 1, 1944, p. 2.

MAINTENANCE OF PLANT NUTRIENTS

The principal nutritional function of compost and animal manures is to keep plant nutrients in circulation. The old agricultural leases which insisted on periodical dunging of the land and forbade the sale of straw and dung off the farm were founded upon a practical if unconscious appreciation of this. The ideal agricultural sales-policy of those days was sound. It was expressed in the saying that "the crops should all walk to market". To-day, however, thanks to artificial supplements, it is no longer needful to observe these old practices in their full rigour, though the rules of good husbandry still apply. In particular, it is essential not to deplete the soil of inorganic nutrients such as lime; and it is essential for other reasons to keep up the stock of organic matter in the soil. The organic matter in the soil may be maintained by several methods including the incorporation of a ley in the rotation; but during the operations of farming there is nevertheless a constant drain of inorganic elements even if nothing more than meat leaves the farm. The diminishing balance can be kept in circulation by intensive composting of plant residues; but the stock of nutrients can only be increased from outside the farm.

Dr. Hugh Nicoll, speaking with particular reference to British agriculture. (Quoted in *Tropical Agriculture*.)

REVIEWS

ALTERNATE HUSBANDRY: Imperial Agricultural Bureaux. Joint Publication No. 6, 1944.

This Bulletin, published by the Imperial Bureaux of Pastures and Forage Crops, Soil Science, Animal Breeding and Genetics, and Animal Health, gives the views of widely divergent research workers on the problem of the better utilization of land. That problem will be of major importance in post-war tropical agriculture, and thus the Bulletin is of particular interest to those whose interests, financial or otherwise, are tied to agricultural production, whether for subsistence or for export. First impressions are that the importance of alternate husbandry may have been overstressed: second thoughts lead to the conclusion that its importance may even have been underestimated.

Briefly, alternate husbandry means a planned and regular alternation of a period of cultivation with a period of stock-feeding, each field in turn being put through the rotation which is most suitable. But natural grass fallow is not sufficient for the animal husbandry period of this sequence, since much better results can be obtained by *cultivating* a suitable grass or grass mixture, giving more food for the animals and better soil conditions for the succeeding arable period. To quote p. 72 "the term 'ley' is used rather loosely to denote a sward or crop produced by the cultivation of herbage and forage crops in a rotation, provided the species employed are of soil-improving and not soil-exhausting kind". In Great Britain and other temperate countries a great deal has already been done in selecting suitable seed mixtures for the ley period, but the wide range of soils and climates in tropical countries renders the problem more difficult and the need for investigation more pressing. The published work of the East African agricultural departments has been abstracted, and due credit is given to Uganda for being the first colonial territory to adopt the grass resting period as the cornerstone of its agricultural policy. Although resting under grass is a definite advance on the old policy of continued exploitation of the soil, or of shifting cultivation with bush fallow as the resting period, it is not enough merely to *rest* the soil. The ley period should be one in which the soil is enriched, and a store of plant food should be accumulated for the coming arable period, while a marked improvement in the soil structure should result from good grassland management.

A quotation from Sir R. George Stapledon given on p. 10 shows the importance of the ley period. "The philosophy of ley-farming turns upon the humus-giving and fertility-sustaining power of the grass sod, and the aim of the ley-farmer is to use that power to the maximum. Nothing the animal returns to the sod is wasted, and by good management the aim should be to maintain an actively-growing root system together with a rapid decay of those parts of the vegetation that normally die each year. In effect the ley-farmer is making and ploughing in compost, doing so cheaply and carrying the operation all round his farm in an ordered sequence. The essential thing is to plough-down the sod while it is still capable of active growth, and still capable of supporting a large head of stock. In short, always to plough-down a sod at once, full of white clover and richly impregnated with animal residues, that is to say, to plough-in the ley before any signs of deterioration in the sward have begun to show themselves".

Obviously the farmer in Britain, with his well-fenced fields, would find this comparatively easy, but the more extensive farming systems of East Africa do not lend themselves to this alternation of husbandry. The thought of taking the plough all round an East African farm in an orderly rotation may be fantastic, but it does not mean that the principle cannot be adapted to East African conditions. Extensive experimental work may be required to find and test a rotational system which is reasonably cheap to set up and which will show increased profit; and the advantage in some areas may be a slowing-down of soil deterioration rather than an immediate increase in soil fertility. The tsetse-fly areas present a separate problem, and large areas of the African territories must be ruled out of consideration in that account, but the underlying principle remains that some means of improving the soil structure and fertility should be sought for the fallow years.

The term "soil structure" which occurs frequently throughout the Bulletin, is explained on p. 42: "By structure is meant the state of aggregation of the soil particles, and on it depend the principal air and water regimes of the soil. In a completely unaggregated or structureless soil, the separate particles tend to pack into the smallest possible space, producing a minimum of porosity, aeration, permeability, and water-holding capacity. These are all

qualities which are indispensable to the healthy growth of cultivated crops". Applications of farm-yard manure or compost, which are usually very effective in establishing a crop, have only a limited period of effectiveness in humid tropical climates, since the rate of decomposition of vegetable matter is very much greater under those conditions than in temperate climates. A temporary improvement in soil structure may, and usually does, result from heavy dressings of organic manures, but the importance of the root system of a grass crop is relation to soil structure is brought out on p. 43: "The significance of the mechanical action of the roots is shown by the fact that humus manuring by itself is not nearly so effective a structure forming measure as the growing of perennial grasses". An example from Russia is quoted on p. 44 in which the application of dung, lime, and artificials to cultivated land did not appreciably improve soil structure, but the soil type used (podzolic loam) may be less tractable than many East African soils.

The improvement of soil structure is the keynote throughout the Bulletin, and, from investigations which are summarized, it appears that increased fertility is attributable more to an improvement in the structure of the soil than to an increase in its store of plant nutrients. A permeable and porous soil, moreover, recovers from the effects of drought much more rapidly, and responds more readily to moisture-conserving cultural operations, than does one which does not possess these qualities to a marked degree.

The sections dealing with East Africa will be of particular interest, and they show that any attempt to follow blindly the rotational methods used in other countries may lead to disaster. The work which has been carried out in Britain and elsewhere can only lay a foundation for experimental work in these territories, but drastic changes will be necessary in areas where soil deterioration and soil erosion are threatening the very lives of inhabitants.

DISEASES OF CROP PLANTS—A TEN YEARS' REVIEW: *Min. of Agric. and Fish., Bull.* No. 126, 101 pp., 8 pl., 1 map, 1943. H.M. Stationery Office, London. Price Sh. 2 net.

This is a further report in the series and follows the same general plan as the preceding one which was published in 1934 as Ministry of Agriculture and Fisheries Bulletin No. 79, and which dealt with the years 1928-1932. It is compiled by W. C. Moore, M.A. (Min. of Agric. and Fish. Plant Pathological Laboratory, Harpenden), and is based on the monthly reports on the incidence and severity of plant diseases in England and Wales supplied by the Advisory Mycologists, as well as on information received from other sources, official and unofficial. A full list of collaborators is given.

Symptomatic description does not come within the scope of the pamphlet, the object of which is to provide a comprehensive list of plant diseases with information on their relative seasonal prevalence and regional distribution during the ten-year period. References are given to relevant literature published in Great Britain, and foreign literature is cited in special cases. Results of recent researches into control measures are indicated in connextion with the more important diseases.

Since the incidence and severity of plant diseases can, broadly speaking, be correlated with weather, a preliminary section deals briefly with this subject.

The crops are listed under the general headings Cereals, Potatoes, Roots and Fodder Crops, Pulse, Pasture and Forage Crops, Vegetables, Fruit, Hops, Mushroom, Flax, and Ornamentals. Previously the diseases of bulbs and corms were dealt with in a separate publication (Min. of Agric. and Fish. Bull. No. 117, "Diseases of Bulbs and Corms"); here they are incorporated with diseases of ornamentals, but in certain specified cases only information not given in the above-mentioned pamphlet is included. Disease names conform, as far as possible, to those used in the British Mycological Society's forthcoming "List of Common British Plant Diseases", a newer and fuller edition of the "List of Common Names of British Plant Diseases".

Over fourteen pages are devoted to potato diseases. In connexion with blight (*Phytophthora infestans*) control, the best results in preventing the disease developing in store or in transit have been obtained by dipping the tubers immediately after lifting in solutions of organo-mercury compounds or formaldehyde. The practice of spraying the potato crop (in England) with sulphuric acid in August or September, which was originally intended to kill haulms and weeds and thereby make harvesting earlier and easier, has been shown also to reduce the tuber losses from blight. Sulphuric acid can be effectively replaced by a mixture of two per cent copper sulphate and two per cent common salt.

A comprehensive index, and eight excellent plates of less well-known diseases are included.

This bulletin provides in small space much information useful to anyone with agricultural or horticultural interests, and should prove invaluable to those engaged in plant pathological work.

M.M.W.

CHAKULA KILETACHO AFYA by Culwick and Ratcliffe: The kinds of Food that give health (S.P.C.K. and C.M.S. Bookshop, Nairobi). Price 30 cents.

The average European in the Colonies, whose diet is of course vastly superior in quality to that consumed by the African, is usually less well informed on the importance of diet to the attainment of good health than are the English public. In the past few years the latter have been made increasingly conscious by articles in the Press and by posters. Our African population is of course almost completely ignorant on the subject.

The general aim of providing an adequate diet for all in the post-war world has been approved by the Allied Governments and it was Dr. L. J. Harris in 1937 who wrote: "when we consider the striking evidence recently gained of how much can be done to improve health, stature and physique by purely dietary means—can anyone doubt that we have here the key to the building of a future race which when compared with our own will seem 'men like gods'." Before we can achieve this aim in East Africa several difficult problems have to be solved. One problem is that of educating the African on the main issues involved and this little booklet gives in 20 pages of simple Swahili the main facts concerning the effects of food on health.

The contents of the book are divided into seven chapters as follows:—

1. *Everybody wishes to attain good health.*—Introductory.

2. *A man's body is like a machine.*—The body of a man is compared to a motor car. In addition to petrol, a car requires water, oil and air. It also needs care in operation and periodical repair.

3. *Care of the body.*—The analogy is continued: the part food plays in body maintenance and repair is explained.

4. *Classification of Foods.*—The African method for classifying foodstuffs has been wisely adopted. There are six classes:—

(*a*) *Chakula*: maize meal and other staples.
(*b*) *Kitoweo*: relishes such as meat and fish.
(*c*) Vegetables of the bean type.
(*d*) Green vegetables.
(*e*) Condiments: including salt, oil, tomatoes, onions and chillies.
(*f*) Fruit.

The composition of a satisfactory diet on the basis of the above classification is then developed.

5. *Reserve Food stocks.*—The dangers of the depletion of foodstocks by the indiscriminate brewing of beer after the harvest is stressed and the opportunity taken to develop the idea of reserves required for the unborn and the infant and the need for increased food-intake by the expectant and nursing mother.

6. *Preparation and Cooking of Food.*—So many books on dietary requirements stop at the mechanical analogy and fail to stress the importance of providing food in an appetising form. It is therefore refreshing to find a chapter devoted to this important subject. After the food has been grown and made available it has to be prepared and cooked. Too often a good institutional dietary scale is ruined both in nutritive value and in palatability by wrong methods of cooking. The importance of teaching the elements of cooking to Africans and especially African girls could well form the subject of a separate pamphlet.

7. *Food-deficiency diseases.*—This must have the most difficult portion of the book for the authors. If the mark of a good sermon is for it to end with a description of the horrors of hell, the symptoms of food deficiency diseases described should encourage a respect for the lessons in the earlier chapters.

Unlike many publications, the Swahili is simple and should be easily understood even by up-country Africans. The appeal of the book is reinforced by an attractive cover design from the pen of Miss Bush. On it is depicted an African woman engaged in preparing a stew from the main classes of foodstuffs described in chapter 4. The fragrant odours from the cooking pot curl up and almost cause our mouths to water at the thought of the good things within.

The book sells for the modest sum of 30 cents. At least one copy should be available at all schools, missions and other institutions interested in any phase of the education of the African.

W.D.R., Z.N.

THE QUEENSLAND JOURNAL OF AGRICULTURAL SCIENCE (Vol. 1, No. 1, March, 1944):

We welcome the publication of the above quarterly journal, the appearance of which at this time serves to emphasize the changed outlook towards agricultural research brought about by the improved war situation in the Far East. To judge by the contents of this first number, the journal will contain much that is relevant to scientific workers in East Africa.

THE MANAGEMENT OF DAMS, Parts I and II.

Those interested in the construction and management of dams on estates, or in native reserves, should consult these original pamphlets by R. H. Pullen-Burry published in the *Bulletin of the Sisal Growers' Association* (Kenya). The author ranges widely over his ground, or water, and deals with such diverse subjects as dam construction, mosquito control, stocking, the habits of *Tilapia nigra*, fishing methods, muddiness in fish, boat building and, finally, the construction of fish traps. This last subject is dealt with at some length, the evolution and construction of a successful trap, based on numerous experiments, being described.

A.G.H.

THE LAND-USE MOVEMENT IN WEST AFRICA by J. N. Oliphant, C.M.G. Issued as a Supplement to *Farm and Forest* and reprinted from *Forestry Abstracts*, Vol. 4, No. 4, 1943. Published by Imperial Forestry Bureau.

A valuable article which starts by rightly assuming that the need for rural planning in Africa is already sufficiently obvious and then proceeds to discuss the administrative approach to the problem. The views put forward, although based on Nigerian experience, are of considerable interest to administrative, agricultural and forestry officers in East Africa who are facing parallel problems to those of West Africa.

There is a very useful bibliography of West African literature. For some reason no other literature is quoted.

A.G.H.

A WORKING PLAN FOR SETTLEMENT FORESTS IN LANGO DISTRICT, UGANDA: C. S. Cree, B.A., A.C.F., D.F.O., Acholi and Madi.

This publication should be accorded notice as following the very practical example of the Indian Forest Service of printing and publishing their working plans. Viewed strictly it is not the complete plan but only war-time difficulties of paper and printing have prevented it from being a model for East African forest departments to emulate. The area dealt with evidently carries what Marbut and Shantz (Vegetation and Soils of Africa) would call "High Grass—Low Tree—Savanna" which is possibly the third most extensive formation in Africa. It forms a belt between Rain Forest proper and the "Acacia tall grass savana", or the "Dry Forest" (Myombo). Its silvicultural management depends on whether local conditions under fire protection could elevate it towards the former type or merely raise its status in the orginal formation. The rainfall at Ngetta (54 in. well distributed) indicates that in places the former would be the case. If one, who has not given the attention that Mr. C. S. Cree has evidently given to the area, might make suggestions: Would not the time saved warrant the extra cost of complete fire protection (paragraph 51)? In similar projects on the Gold Coast, teak is worked very successfully for hut poles on a coppice system and this species might be added to the planting list (paragraph 55).

L.G.T.W.

THE DIAGNOSIS OF MINERAL DEFICIENCIES IN PLANTS BY VISUAL SYMPTOMS. A COLOUR ATLAS AND GUIDE: By T. Wallace. Published by His Majesty's Stationery Office, London. Price Sh. 10.

This useful handbook with 52 pages of written matter and 114 coloured plates from colour photographs, published under the auspices of the Agricultural Research Council in March, 1943, has been written primarily for technical officers and qualified advisers concerned with crop production. It can also be used to advantage by many intelligent farmers and horticulturists in the case of the best-known deficiency symptoms of common crops, but great caution must be exercised not to confuse similar-looking symptoms and more especially not to attempt to fit in certain somewhat different characteristic field symptoms with what appear to be the most similar deficiency symptoms shown in the colour atlas. Illustrations of nitrogen-deficiency symptoms, which are usually the easiest to diagnose, are not included and the atlas does not, of course, give all the deficiency symptoms for all crops. One will often come across cases of visual leaf symptoms which cannot be correlated with recorded deficiency symptoms. Technical officers and farmers in East Africa will be aware of certain characteristic growth symptoms, e.g.

those peculiar to coffee and deciduous fruit trees, which are quite dissimilar from any shown in the illustrations and there are complications brought about by pests, diseases and different climatic conditions which need not result from nutrient deficiencies. Even known deficiency symptoms will often vary somewhat from the particular coloured plates chosen for this album. This is illustrated by comparing this particular colour album with others, such as that contained in the publication *Hunger Signs in Crops* produced in the United States. Coloured plates often illustrate severe and prolonged deficiency symptoms whereas specimens taken from field crops usually show any of the successive stages of mild deficiency symptoms. Care must be taken not to attempt to extract too much information as to the manurial requirements of field crops. Dr. Wallace's long association with the Agricultural and Horticultural Research Station at Long Ashton, where he has directed a team of workers on the general nutrition of fruit trees, is reflected in the special attention given to a wide range of temperate fruit crops. This gives added value to this particular book as the diagnosis of mineral deficiencies in fruit crops is not so fully dealt with in other similar publications.

The first three chapters of the book, covering 26 pages, give a good summary of the principles of plant nutrition and the role played by varying soil conditions in modifying plant growth. Their reading serves as a suitable brief refresher course to agricultural officers and others who may be becoming stale in this subject. These chapters are followed by one giving a brief account of the outstanding symptoms resulting from deficiencies of nitrogen, phosphorus, calcium, magnesium, potassium, iron, manganese and boron in a range of economic plants, with very brief notes on the role of a few other minor elements. A guide in the form of a three-column table, giving the important symptoms for diagnosing mineral deficiencies for different classes and kinds of crops, offers suitable clues to the likely responsible deficiency: this can then be checked up by referring to the coloured plates wherever these have been supplied. The coloured plates, though necessarily somewhat small in size in a war-time publication, are well taken and generally illustrate the specific symptoms referred to in the guide.

Dr. Wallace's suggested system of using suitable indicator plants in field fertilizer trials deserves special mention. It is difficult to determine a possible range of unknown mineral deficiencies in a given soil by the field performance of one crop only, but the use of chosen susceptible plants to check on each specific deficiency makes the task much easier. In the plants suggested, the anticipated symptoms are generally pronounced and unlike those for other deficiencies on the same plants. Many of the specific symptoms, with the exception of those for nitrogen deficiency, are illustrated in the accompanying coloured plates. Some of the proposed indicator plants, which are markedly susceptible to particular mineral deficiencies and which do well under East African conditions, are fully worthy of field trials by technical and agricultural officers.

This publication is a valuable addition to the literature on visual symptoms of mineral deficiencies and constitutes a useful guide on the subject to technical and agricultural officers in East Africa. G.H.G.-J.

SOIL FERTILITY: (*Farming in South Africa* 18, No. 210 September, 1943. Department of Agriculture and Forestry, Pretoria. Price 6d. Annual Subscription Sh. 5).

It is encouraging to notice how opportunely the world has become soil conscious. The dust bowl of America was formed in the effort to grow more and more food for a world at war; an effort rewarded by immediate profit at the expense of capital—the soil. Now, as another great war absorbs most of the energies of the world, the need for agricultural production is greater than ever. But, this time there is no reason why the soil should suffer if only farmers and all others engaged in the production campaign will pay more than lip service to the principles of soil conservation. Dr. P. R. Viljoen, Secretary of Agriculture and Forestry in the Union of South Africa, expressed the ideal when he called for "the rational production of foodstuffs whereby veld and soil will not only be preserved in good condition for those that come after but will even be improved". This is quoted from the foreword to a special Soil Fertility number of *Farming in South Africa.*

Whilst it may be difficult for some of us to appreciate the range of soil and climate in the Union, or the differences in agricultural conditions between South and East Africa, it will well repay any farmer or anyone who intends to farm or anyone connected with the production campaign to study this issue. It contains articles, on all aspects of the problem of the maintenance of soil fertility, written for farmers by research officers and agronomists.

There is general agreement on the value of organic manures although several authors emphasize the temporary nature of the benefits obtained. Some maintain that their value lies only in providing food for micro-organisms and thus indirectly for the crop, while others go much further and ascribe to humus all the credit for soil fertility. In spite of this apparent divergence of opinion, all are agreed that no organic residues, whether of farm or municipality, should be wasted; they should be returned to the land especially during the present shortage of fertilizers.

It is quite clear that there will never be enough organic manure to provide adequate dressings, for this reason many of the authors advocate rotations that include legumes or leys or both. The case for the ley is forcefully stated by Dr. Fisher of Cedara (pp. 641-4) who stipulates for a resting period at least as long as that of cultivation: he instances a five-year pasture following five years arable. In East Africa on the lighter soils this would be an excessive period of cultivation because in that time the soil structure would be reduced to the point at which the re-establishment of a good pasture would be delayed. The rotation must be planned limiting the arable period to the economic minimum and avoiding superfluous cultivation during that period in order that each succeeding ley shall provide better food more quickly for the stock. The slogan must be not merely maintenance but improvement of soil fertility.

Of the mineral nutrients it appears that phosphates are deficient in most of the Union soils. Many soils in East Africa are similarly deficient and also acid so that soluble phosphatic fertilizers quickly revert to insoluble iron phosphates. There is evidence that phosphate in organic combination is not "fixed". It is probable therefore that it would be more economical to apply the phosphate to the ley so that it becomes available to the succeeding arable crops gradually by the decomposition of organic matter.

No farmer in East Africa is likely to question the value of trees; many would say that at least fifteen per cent of a farm area should be tree clad. One regrets that the article on trees (p. 673) did not give us more advice on where to plant trees. In one short paragraph Mr. J. J. Voorendyk is inclined to claim the flat land for his trees but some would find it more economical to reserve the steeper slopes and non-arable portions of the farm for trees. In stating that "The moisture in the top soil is evaporated by the sun and wind and the moisture in the subsoil then continually moves upwards by capillary action also to be evaporated in due course" Mr. Voorendyk seems to have lost sight of Dr. B. A. Keen's work on evaporation from soil surfaces which disposed of the capillarity theory.

It is interesting to note that among the simple counter erosion measures discussed by Dr. J. C. Fick (p. 50) are the contour grass strips which have been so useful in Uganda where we hope finally to develop true contour strip cropping in combination with the ley. Farmers in South Africa are all at liberty to seek amplification of these articles or further advice from the nearest agricultural station. Similarly farmers in East Africa would profit by discussing together and with their nearest Agricultural Officer the special points which affect them, thus avoiding the error of applying to their own farms advice intended for entirely different climatic and soil conditions. The need for food production is urgent, but farmers would do well to plan now for the future of their soil by absorbing the principles enunciated in this useful volume. All the papers are short and interesting but an authoritative summing up at the end of the issue would have added to its value.

W.S.M.

LOOKING ABROAD, LOOKING AROUND, LOOKING AHEAD: Reflections on land policies with special reference to Kenya problems, by Colin Maher. East African Problems No. 1, published by the East African Standard, Ltd., Nairobi, Kenya Colony, pp. 58, price Sh. 1/25.

Post-war development is in everyone's mind at present—not only development, but improvement in its widest sense. Some of us look to the future with super-optimism, others with unwarranted pessimism, and there is a tendency to think fancifully of what should be done to ignore the difficulties which arise when practical details are considered. Hard common sense, so uncommon in reality, must be applied to most post-war problems, and we must learn from the successes and failures of others if short cuts to prosperity are to be found.

Maher's booklet is stimulating, and although it may stimulate some to active disagreement, it is worth reading even by the most conservative. He has summarized the successes and failures of the land policies of other countries before dealing with East Africa, in order to

give the reader every opportunity of getting away from "backyard politics". This section in which he looks abroad shows that the land problems of East Africa, large and difficult though they are, seem rather small when compared with those now facing the Governments of Britain and the United States, or those which had to be tackled by the U.S.S.R. during the past 25 years. Seventeen references are given, mostly of a type which anyone could read with interest, should he wish further information on any of the points discussed.

Throughout the book runs the theme that security of land tenure is necessary, but at the same time no one should be allowed to misuse land to the detriment of the community as a whole. A man may purchase a bicycle and immediately set about breaking it into small pieces without interfering in any way with the comfort or well-being of his neighbours: on the other hand, if he buys a piece of land and farms it badly his actions may seriously affect his neighbours and their successors. Maher argues that the utilization of land is ultimately a state responsibility, and he even suggests that Government should assume full landlordship by purchase. "Good husbandry" clauses should be inserted in the leases, which would carry security of tenure and right of inheritance of the lease. Compensations for improvements by tenants would be valued, at the conclusion of a lease, by a method similar to that employed in England.

However drastic and unwelcome to "lovers of freedom" this suggestion may be, it has the point in its favour that it would solve many of the agricultural problems of to-day. The criticism that "it won't work in practice" may be backed by sound arguments, but it is obvious that some very drastic change is required in order to ensure permanent soil fertility and stability in agricultural economics. If any one knows of a better plan which does not involve state control, let him bring it forward. If no such plan is forthcoming, regional planning, even with Government landlordship, will have to be considered seriously. We wonder what kind of reception the Beveridge Plan would have had ten years ago.

Many of us do not want to take Maher's advice. It means large financial entries in still larger ledgers, packs of Government auditors on the prowl to see that everything is carried out according to regulations, and all the inspections, supervision of inspectors, and direction of supervisors which Government procedure demands, as compared with the care-free individualism which has been our pride in the past. But, as Maher says, the rugged individual needs to be rugged, and how often is he really care-free? He seems to drag out a careworn existence between boom periods, thinking of the previous times of relatively easy money and hoping that the next will come soon; and perhaps even a Government inspector at the door would be preferable to the proverbial wolf. We recommend that Maher's booklet should be widely read, not because we agree with all he says, but in the faint hope that it will stimulate someone to produce a really easy solution to the post-war problems of East African agriculture.

D.W.D.

The social effect of a cultural movement, such as science, is very largely produced unconsciously. People who think of scientists as wizards with magnetic eyes may still, unconsciously, show an influence of scientific thought when they come to decide practical questions. Science is, after all, largely a matter of common sense; and common-sense, matter-of-fact thinking is undoubtedly applied to a much wider range of phenomena nowadays than it used to be. Not, of course, that the range is nearly as wide as one would like. But at least the basis is there. When people discover what the method of science is, they find it is something they have known all along. They have not got the same resistance against it as they would against some totally new kind of thinking, such as Yoga.

This is particularly so at the present time, when the hard realities of the war insist on something which gets results. For the way to get results is science. Londoners, and others, have devoted quite a lot of thought to the problem of the night bombers, and they think, not of exorcising them by spells, but of dealing with them on scientific lines. Most of the older scales of value, which could compete with the scientific attitude, have had the bottom knocked out of them by the sheer pressure of material happenings. The public mind is ready for science; it is up to scientists to see that they get it.

Dr. C. H. Waddington in *The Scientific Attitude*.

CORRESPONDENCE

ONCE MORE—THE GOAT

The Editor, East African Agricultural Journal.

Sir,

From your Foreword to the October, 1944, number of this Journal, and from the first paragraph of Dr. French's important paper on "The Feeding of Goats", one might gain the impression that there are two warring schools of thought on our old enemy and friend, the goat: To the one it is impudent and destructive, to the other a most useful animal. And the pendulum swings backward and forward from one extreme view to the other. All extremists are dangerous, and it therefore behoves the mind accustomed to steer a middle course to warn against their bamboozling emphases!

Let us be quite clear: Everyone is agreed that the goat is, above all, the browsing animal *par excellence*, and thereby a destroyer of bush and weeds and—rather important—of tree saplings. Nature having made him like this, it is obviously futile to blame or praise him. Thus, actually the warring schools are not fighting over the goat but over the bush. In other words, to those who, for one good reason or another, want to protect the bush the goat is an enemy; to others who, for other good reasons, want to keep the bush down, he is a most helpful friend. The problem of one's attitude to the goat thus becomes quite simple to my mind: If I desire to prevent increasing run-off from, and thereby accelerated erosion of and decreasing permanent stream-flow from hill slopes, or if I wish to rehabilitate impoverished slope soils by re-establishing bush or timber on them (both, natural or artificial), I must quite obviously keep my goat enemy out, if necessary with the aid of barbed wire. If, on the other hand, my endeavours lie in the direction of preserving or creating grassland pastures (again, natural or artificial), I shall welcome my goat friend—in appropriate numbers—as a helpmate. That, as I see it, is all there is to the goat problem. . . .

From the practical, as distinct from the purely theoretical point of view it all boils down once more, as in so many fields of human effort and enterprise, to control based on a thorough understanding of Nature, our great Mother, so sublimely unconcerned with praise and abuse alike.

As an excellent and encouraging example of my point of view we have the Mpwapwa experiments, where controlled goat-browsing not only maintains the pastures in the valleys against invading bush, but automatically prevents the spread of tsetse into country usefully occupied by man; but where likewise the goat, no longer forced to nibble the adjoining bushed or timbered hill slopes in search of food, keeps out of them and thus leaves them intact as essential providers of permanent domestic water for the valley dwellers. All, I repeat, quite simple once science has provided the data for deciding correctly the controlled number of goats: there must, obviously, be sufficient of them to keep bush and fly invasions from the pastures and to provide milk and meat for the peasant—not to forget "bride money"; but their numbers must not be allowed to become so excessive that part of them will again have to look for sustenance in the surrounding bush of the slopes.

Dar es Salaam,
6th October, 1944. C. GILLMAN.

TSETSE POLICY

The Editor, East African Agricultural Journal.

Sir,

How anyone can read into—or out of—my short summing up of the Tsetse Problem in my "Note on the Mpwapwa Experiments" (this Journal, January, 1943, p. 157) that I am an advocate of the "steam roller methods of sheer clearing", is beyond my understanding. But as Mr. Napier Bax has evidently managed to do so in his, in many ways very useful and elucidating, recent paper on Tsetse Reclamation Policy (this Journal, vol. IX, 1944, p. 158, footnote), I shall be grateful if you will publish the following defence against such a charge.

All I have stated in the article quoted is that "the most efficient way of combating the pest would seem to be one that removes both essential environmental factors", and that "this is undoubtedly done by close human settlement"; and I then point out that this is also the cheapest way. These are mere statements of undeniable facts which not even he can overlook or ignore who, like me, has for a long time been among the most fervent exposers of the dangers to the land inherent in the Cultivation Steppe, i.e. in Mr. Napier Bax's parlance in the "steam roller method". A few quotations from my more recent publications will, I trust, make my attitude clear:

First and foremost, is not my whole article on the Mpwapwa Experiments an expression of my delight that something is being experimented with which will lead to a more bene

ficial use of the land than the Cultivation Steppe? Then there is my *Presidential Address to the South African Geographical Society* of 1938 (*S.A. Geogr. J.*, 1938) in the course of which I said (p. 18), after having described the Cultivation Steppe: "The very birth of the C.S., thus, carries with it the germ of final death and the rate of decay has, naturally, been hastened by the pacifying influences of European administration to such an extent that the cry for land reserves is becoming ever louder and more perturbing". And on the next page, when dealing with the influence of the tsetse problem on the "waste lands" which might be looked upon as potential land reserves, I continue: "The most advanced results of these (i.e. tsetse) researches, to my mind, is the following far-reaching vision by that indefatigable fighter against fly, Mr. Swynnerton . . .: his great aim is nothing less than an entirely new type of utilization of the tall grass–tree savannah by shifting cultivation *plus* cattle, and would thus, once and for all, do away with the menace of the C.S. He expects, if I interpret him correctly, to achieve this in a twofold manner: by eradication of fly to make the savannah safe at a much lower density of men and cattle than that required for the maintenance of a C.S.; and by defending as yet uninfested savannah, to prevent the compression of its scattered population into fresh C.S. Whether he will succeed must, for the present at least, remain an open question". In *The Geography and Hydrography of the Ruvuma Basin* (Water Consultant's Report No. V, 1940) I have suggested to utilize the comparatively well-watered miombo areas of the Southern Province by creating small fly-free enclaves: "These might conveniently be started on or near the valley bottoms on which, without stripping the natural vegetation down to the limit of the C.S., ground would gradually be established permanently and sufficiently open to become unpalatable to fly and thus ready to receive the small cattle population essential for mixed farming" (p. 31). In the same year, in my *Reconnaissance Survey of the Hydrology of Tanganyika Territory* (Water Consultant's Report No. VI, 1940), I repeat (p. 74) almost verbally what I had told the S.A. Geographical Society two years earlier; and on p. 76, when dealing with the creation of new water supplies by "manipulating vegetation", I clearly state: "every conceivable precaution must be taken from the very beginning of any planned scheme of manipulated areas for settlement to prevent such areas from degenerating into small or large C.S. by indiscriminate clearing, wasteful tilling, or over-stocking. More particularly with regard to clearing, thinning rather than wholesale cutting of the woodland should be aimed at, which can easily be attained by leaving suitably situated groves of the original vegetation standing which will not only serve as welcome sources of timber and firewood, but, protected from fire as they will have to be, will soon develop into thickets unpalatable to fly, if I interpret Swynnerton's views correctly". And finally in a *Presidential Address to the Dar es Salaam Cultural Society*, of 1944, on the subject of Shifting Cultivation, I stated: "The C.S. made its appearance, and like the cities of the other cultures, starting as a promising and wealth increasing institution, it inevitably spread into cankerous sores of the body politic, leading through accelerated deterioration of forests, soils and water to final decay. Thus we find in the C.S. the tropical equivalent of the sub-tropical 'marching desert' and the temperate 'dust bowl'; and all three have the equilibrium destroying greed of man for common cause." (pp. 2/3.)

Surely, I cannot be called an advocate of the steam roller; rather might I be blamed on superficial evidence for belonging to Mr. Napier Bax's other antagonists, those whom he calls "the more extreme school . . . that tsetse is a trustee of the land". For on pp. 29/30 of my above-quoted Ruvuma Report I have drawn attention to another undeniable fact, namely that 30 to 35 million African natives living between 10 degrees N. and 20 degrees S. Lat., and west of the fortieth meridian "are apparently very well managing to live side by side with the fly and have obviously survived such local epidemics of sleeping sickness as have, no doubt, played havoc in the past"; and that "it is, therefore, time that we realized more fully the great extent of this other type of land occupation practised by a large proportion of Africa's total population on either side of the equator, and which utilizes forest and savannah by the methods of bush-fallowing *with* tsetse but *without* cattle, and does and has done so for times immemorial with apparent success; a type of land use, moreover, which is much more likely to safeguard soil and water than the cattle-riddled C.S."

But even with these facts before me, I am of course no more subscribing to, leave alone advocating, the "Trustee School" than I am to that of the "Steam Roller". My convictions and attitude are clearly these: I have always maintained, and still do maintain, that natural pressure on the land by increasing populations is the best and cheapest antidote to tsetse, especially when it is guided into channels which

will prevent the future creation of fresh Cultivation Steppes; a prospect which now seems to be taking more definite shape thanks to the latest developments in tsetse research so well explained in Mr. Napier Bax's pamphlet. And I further maintain that where population pressure is non-existent, as in vast areas occupied by scattered non-pastoral peoples under their shifting cultivation, wholesale eradication of fly, though no doubt eventually most desirable, is a task less pressing at present than the improvement of domestic water-supplies and of the people's diet, all the more so when anti-sleeping-sickness concentrations are proving so very promising. Where, on the other hand, and mainly in the marginal zone between the fly-free steppes and the fly-infested savannahs and forests, the need of land reserves for the pastoral peoples is as urgent as in parts of T.T., tsetse and water research must try to create such reserves in closest co-operation with the Agricultural, Veterinary and Forest Departments.

Dar es Salaam, Sept. 1944. C. GILLMAN.

THE PLACE OF RESEARCH IN THE CONTROL OF INJURIOUS INSECTS

The following items of experience gained in this work deserve notice because they illustrate three fundamental principles in applied entomology. First, that the way to tackle a practical problem is to get right down to it. When that is done the scientific problem becomes clearer. Second, that the research necessary for the solution of practical problems can only be defined when both research and practice keep in the closest touch with one another. In so young a science as biology applied in fields other than medicine it is idle to suppose that research basic to agriculture or to industry or to public health can be planned within the four walls of a laboratory. Third, that the scientific work required for the solution of practical problems cannot be confined by any doctrinaire or academic definition of the branch or branches of science in which it lies. The fact that a practitioner is a zoologist or an entomologist by training is no excuse for his failing to follow his work into chemistry or physics if that is necessary.

Experience in the last three years has stressed another important feature of insect control work. In spite of the great extension of practice and of the greatly increased tempo of research, and particularly of what is called short-term or *ad hoc* research, it is the long-term or basic research which is paying the highest dividends in practical results. This may seem paradoxical. The objectives of short-term or *ad hoc* research are those thought to be within reasonably easy reach, and the research itself usually covers a severely restricted field. The objectives of basic or long-term research are usually distant and the research itself is nearly always planned on a broad basis. It is precisely this planning on a broad basis that makes it valuable not only in science but also in practice, and in the light of the experience of the last three years I am almost tempted to believe that if provision is made for long-range research on a broad basis in which the closest contact is maintained with practice, much of the *ad hoc* work carried out in relation to the control of injurious insects might be dispensed with. That may, however, be to simplify matters too much, because there is often a gap between basic research and practice which can only be filled by *ad hoc* work. On the other hand, my own experience strongly suggests that it might be better if this necessary *ad hoc* work were carried out jointly by the practitioners and the research workers. . . .

In recent years in applied entomology there has grown up a kind of investigation commonly called *ad hoc* research which has in my opinion little value. It is the kind of work which assumes that any kind of investigation, because it relates to an injurious insect or to the use of insecticides, is *ipso facto* of economic or applied scientific value. The literature of economic entomology is overburdened with accounts of work of that kind almost to the despair of the serious research worker and of the practitioner alike, because the work described is too often neither good science nor good practice. The possibility that in economic as in scientific work the discovery of new laws and principles may solve a problem cannot be overlooked, and in seeking to discover new laws and principles relating to insect behaviour or to the mode of action of insecticides, it may be the simpler, if not the only, approach to study quite other insects than the injurious ones and then, having gained an understanding of principles, apply these principles to the solution of the practical problem.

I refer to this misunderstanding of research in applied entomology because recent experience has thrown it into high relief, and because the same experience has emphasized the value of a background of research as free and untrammelled by immediately practical considerations as is possible in a workaday world. . . .

Prof. J. W. Munro in *Nature*, 6-2-43.

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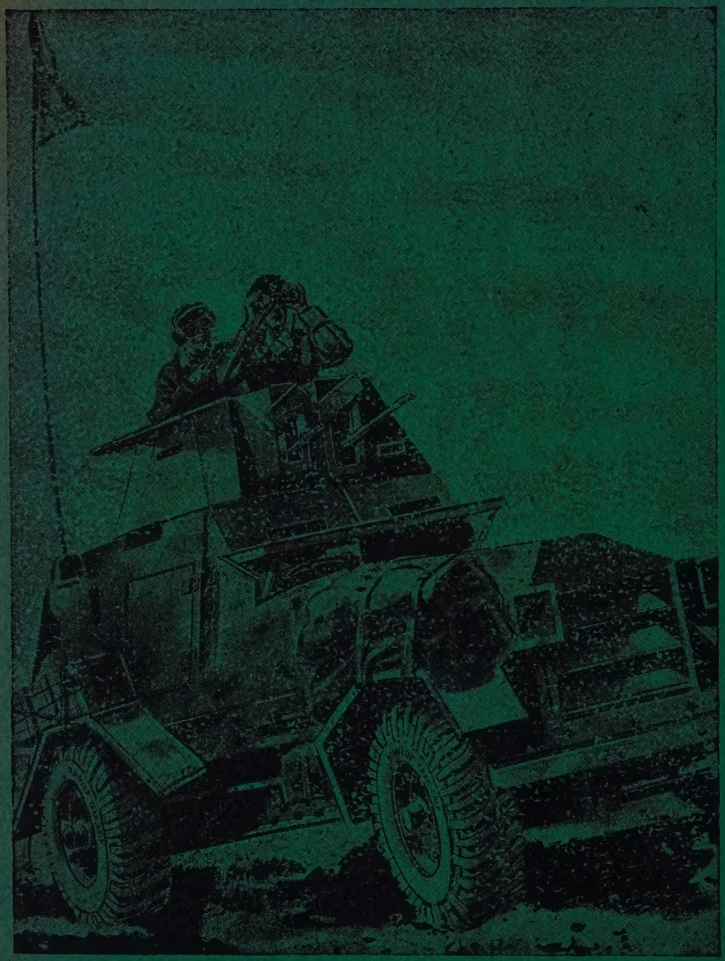

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